

THE
Young GENTLEMAN'S
ASTRONOMY,
CHRONOLOGY,
AND
DIALLING,

Containing such

ELEMENTS of the said
Arts or Sciences, as are most
useful and easy to be known.

By EDWARD WELLS, D. D. late
Rector of *Cotesbach* in *Leicestershire*.

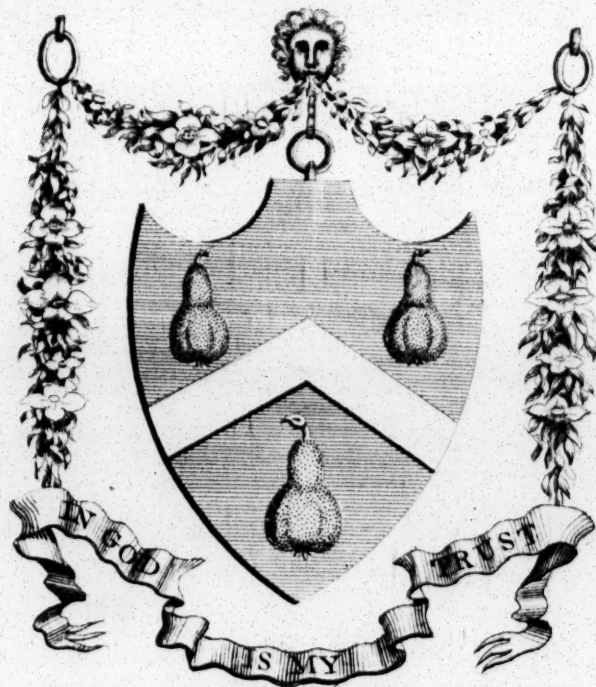
The FOURTH EDITION *Revised and Corrected,*
with ADDITIONS.

L O N D O N:

Printed for JAMES, JOHN, and PAUL
KNAPTON, at the *Crown* in *Ludgate-Street*.
MDCCXXXVI.

no. 34.

Green Street, corner of Church Street, Soho London.



Robert Orchard



T H E
Young Gentleman's
ASTRONOMY,

Containing such

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B Y

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The F O U R T H E D I T I O N.

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M D C C X X X V I.





THE PREFACE.

 *HERE are two Ends of writing Books, which relate to the several Parts of Learning: one to advance Learning it self; the other to assist Learners.*

In Pursuance of the former, the Capaciousness of the Subject is chiefly to be considered; and nothing is to be omitted, which properly falls within the Compass of the Art or Science treated of. In pursuance of the latter, the Capacities of the Learners are principally to be regarded; and notice is to be taken, not of whatever may be known or done by the Art or Science treated of, but only of what is most useful, and withal easy to be known.

Besides, Regard is to be had, as to the Capacities principally, so secondarily to the Circumstances of the Young Students. As for those who are to make their Fortunes by their Learning, more Particulars are requisite to be known, and consequently more Pains are requisite to be taken by such, than by others; who, being born to plentiful Estates, are by

The P R E F A C E.

their Learning not to make, but to adorn their Fortunes already made.

And there is the more Need of this distinct Consideration, because one of the first Things Young Gentlemen become sensible of, is this; that they are not under a Necessity of taking Pains for their Livelibood. Which has such an Influence upon them, as That they are apt not to relish any Part of Learning, which requires more than ordinary Pains or Application of Mind. And indeed to expect they should act otherwise, is in effect no other, than to expect gray Hairs upon young Heads.

Wherefore, the most proper Method to make Young Gentlemen Learned, is this; to teach them at first only such Elements of the liberal Arts or Sciences, as are most useful in the common Affairs of Life, and withal most easy to be known. They have a competent Apprehension of the Usefulness of such Things as occur in the common Concerns of Life; and consequently hereby that Question frequently put by Young Students, of what Use is this? will be answered afore-hand, and so they will be rendered willing to understand what they apprehend the Use of. And when they find that the Understanding thereof carries in it no Difficulty, then they will be also encouraged to proceed. And when they have thus gone through, and become Masters of the most useful and easy Elements of the liberal Arts and Sciences,

The P R E F A C E.

Sciences, they will thereby be enabled with much more Ease to conquer the more difficult Parts of Learning, if their own Inclinations shall lead them thereto hereafter, when they are come to Riper Years, and so can judge more rightly of the Worth of Learning.

On these Considerations, and with this View it was, that I drew up this Astronomical Treatise, and gave it the Title of the Young Gentleman's Astronomy; Such Astronomical Treatises as were afore extant among us; either treating only of the Doctrine of the Sphere or Globe, or else taking in several Particulars of the other Part of Astronomy, too difficult for, and not necessary to be known by Young Gentlemen.

It only remains to be observed, that I suppose Young Gentlemen to proceed regularly in their Studies, and therefore to have learned Arithmetick and Geometry, before they enter upon Astronomy: as also, that such Particulars, as were not necessary to my present Design, and yet seemed too material to be quite omitted; I have added by way of Annotations, both in this Treatise, and the others of Chronology and Dialling.

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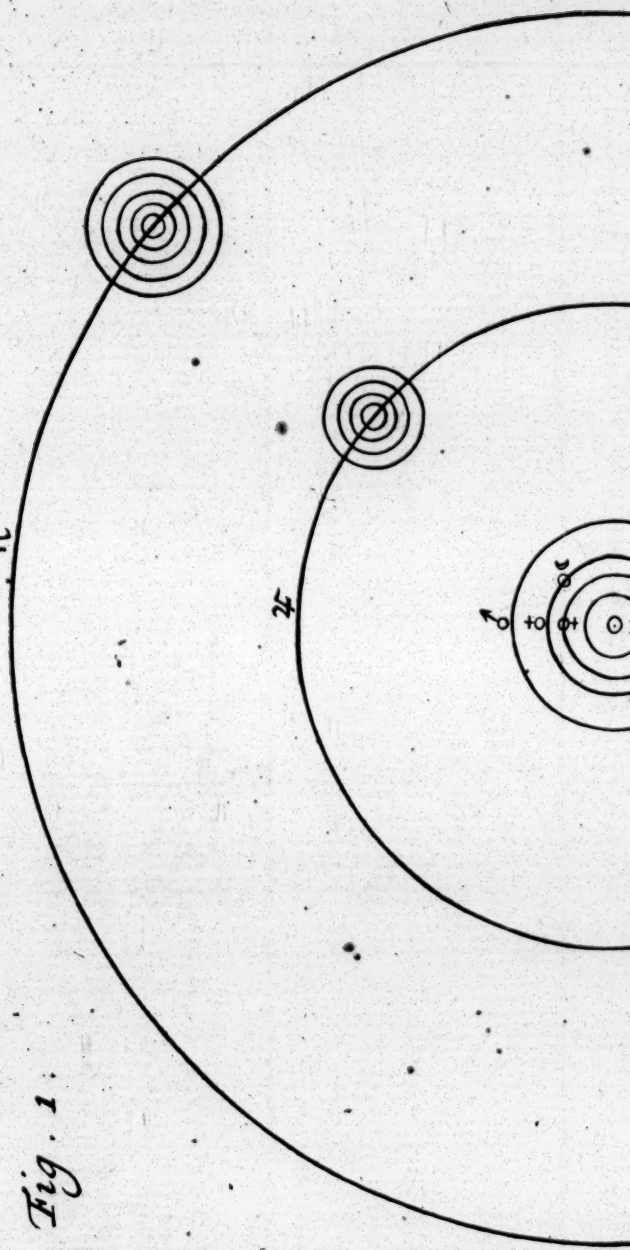


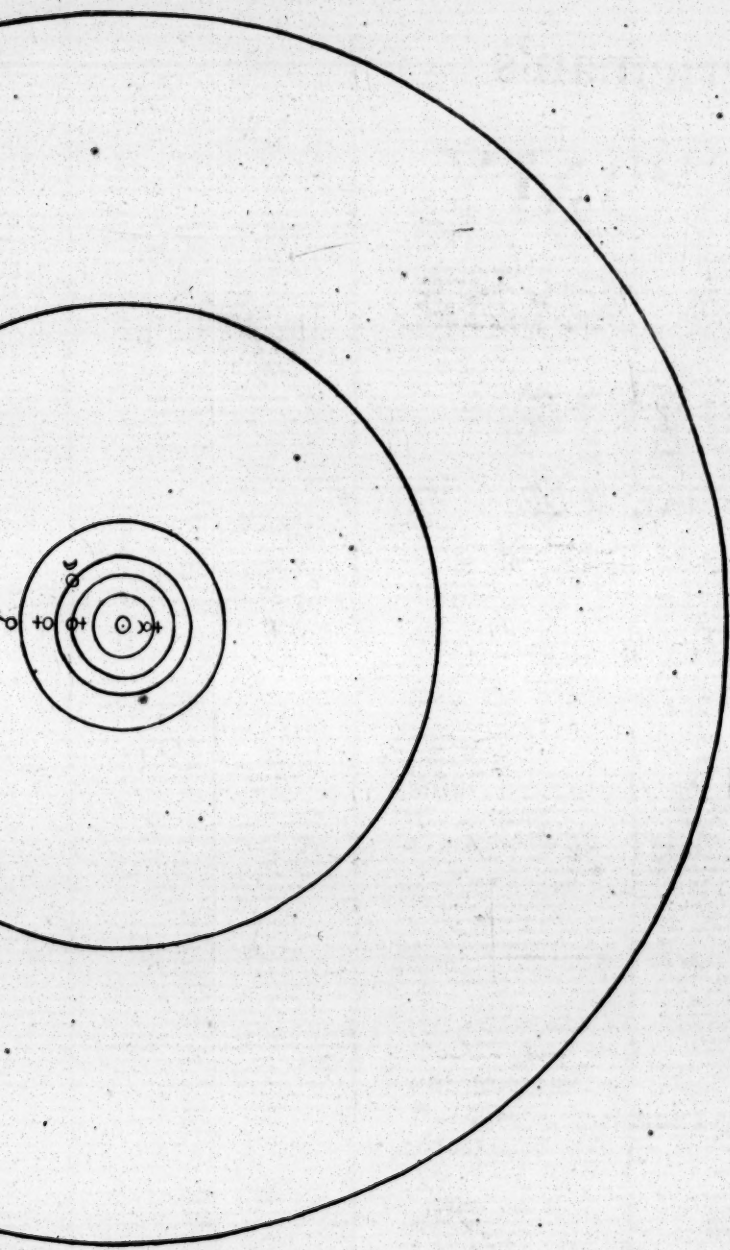
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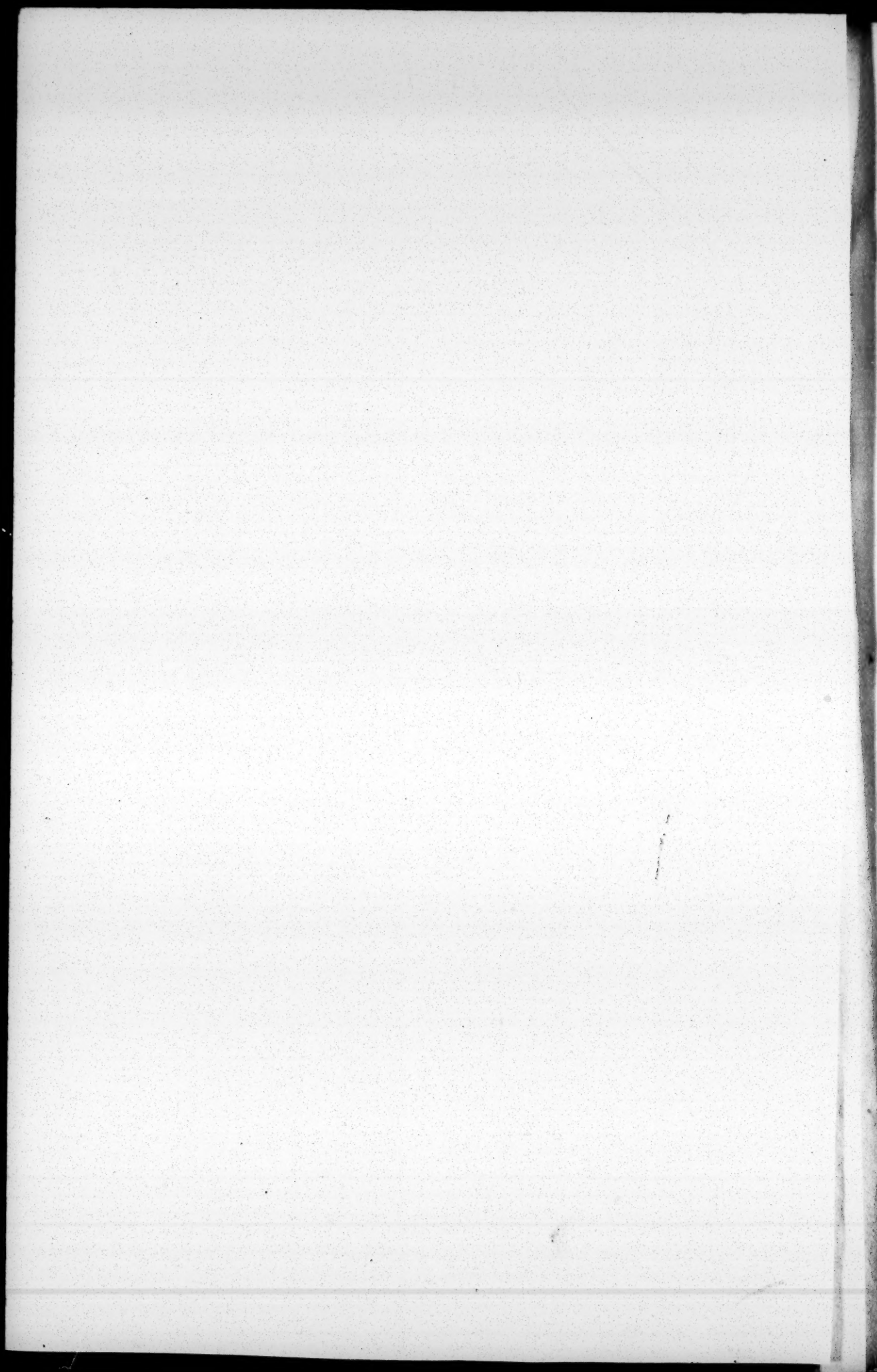
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Astronomy Plate 1.

Fig. 1.









T H E

Young Gentleman's

ASTRONOMY.



The INTRODUCTION.

 E are informed by *Moses* in 1.
his Sacred History of the *The Cele-*
Creation, that God *made* *stial Lights*
Lights in the () wide Space* *made to*
of Heaven, to give Light *what Ends*
upon the Earth, and to divide the Day
from the Night, and to be for Signs and
for Seasons, and for Days and Years,
Gen. i. 14—18.

(*) So the *Hebrew* Word *Rakia* truly signifies. It is rendered in our *English* Bible the *Firmament*, in Conformity to the *Septuagint* Version. See more of this in my *Paraphrase on Genesis*, just published, *Chap. i. 6.* and in Note (i) belonging thereto, in reference to the Word *Firmament*.

B

The

2. The principal Way, whereby the All-wise Creator of the World has rendered the Celestial Lights subservient to the fore-mentioned Ends, is by certain established Laws of *Motion*; according to which, they either *really* move themselves, or at least *seem* to us to move.

The Celestial Lights are made subservient to the Ends, for which they were created, principally by Motion.

3. What these Laws of Motion are, the Divine Wisdom has not thought fit to reveal unto us. Wherefore, all that we can do, is to make probable Conjectures concerning them. Such Conjectures are termed (*) *Hypotheses*, i. e. Suppositions; because it cannot be positively affirmed of the most probable Conjecture, that the Celestial Lights do so move; but only, that it is reasonable to *suppose*, they move so, rather than any other Way; and that upon such a Supposition, their (†) *Phænomena* (or Appearances) may be rationally solved or explained.

We can only make probable Conjectures concerning the Laws of their Motion; which Conjectures are called Hypotheses, and why.

4. The Explanation of these Hypotheses, and the Solution of the Astronomy, *what.*

(*) It is a Greek Word, derived from the Verb *ὑποτίθημι*, to *suppose*.

(†) It is a Greek Word also, derived from the Verb *φαίω*, to *appear*.

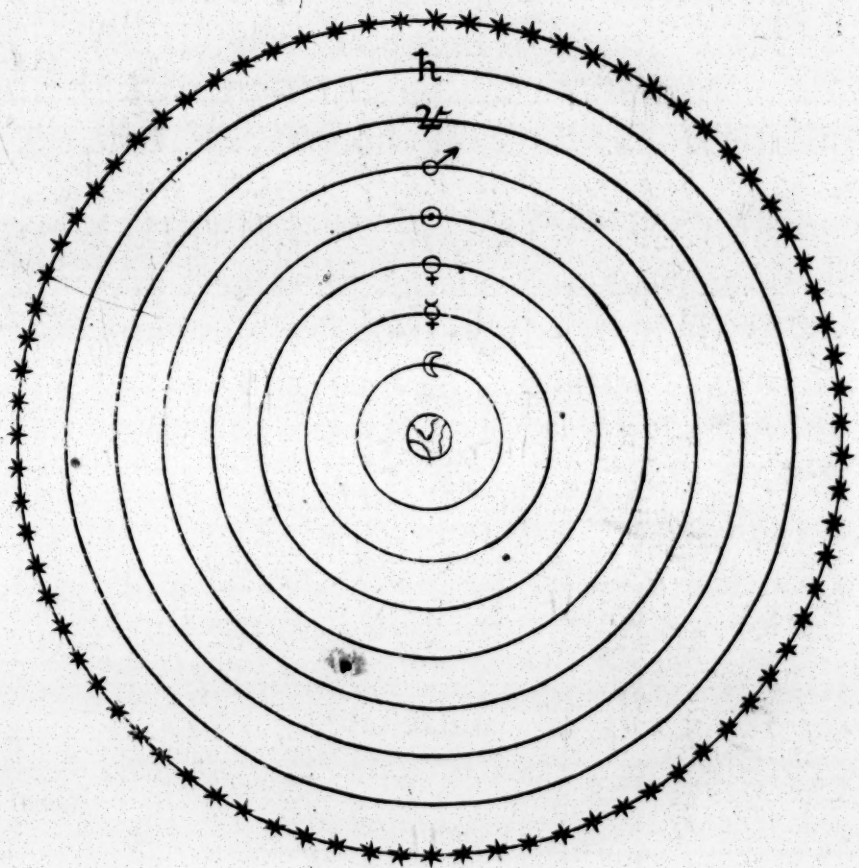
lestial





Place this facing Pag. 3.

Fig. 2.



lestial *Phænomena* thereby, is what makes up the Science called (*) *Astronomy*: which is a *Greek* Word originally, and denotes in that Language the Doctrine or Knowledge of the *Laws*, or of the *Distribution* and *Situation* of the Stars, or Celestial Lights.

There are four more remarkable 5.
Hypotheses, the (†) *Ptolemaick*, the *Copernican*, the *Tychonick*, and the *Semi-tychonick*. Of these the *Coperni-*
can The Copernican Hypothesis, why the most Probable.

(*) This Word may be derived, as to its latter Component, either from νόμος a *Law*, or from νομός a *Distribution*, *Seat*, or *Situation*.

(†) The *Ptolemaick* Hypothesis is so called from *Claudius Ptolemaus*, a famous Mathematician of *Pelusium* in *Egypt*, who lived in the former Part of the second Century after Christ, under the *Roman* Emperours *Adrian* and *Antoninus Pius*. He writ both of *Astronomy* and *Geography*; and by his *Astronomical* Writings, was conveyed to succeeding Ages, the Hypothesis which goes under his Name, and which was generally, not to say universally, received in these Parts of the World till the Days of *Copernicus*. The Order of the Celestial Lights as to their Situation, according to this Hypothesis, is represented, *Fig. 2*. But since, by the Help of *Telescopes*, the Phases of *Venus* and *Mercury* have been discovered, this Hypothesis is rejected, as not consistent therewith. I pass by the *Epicycles*, and several other Particulars justly blameable in this Hypothesis.

Copernicus, who was born in 1473 at *Thorn*, a Town of Polish *Prussia*, perceiving the several Exceptions

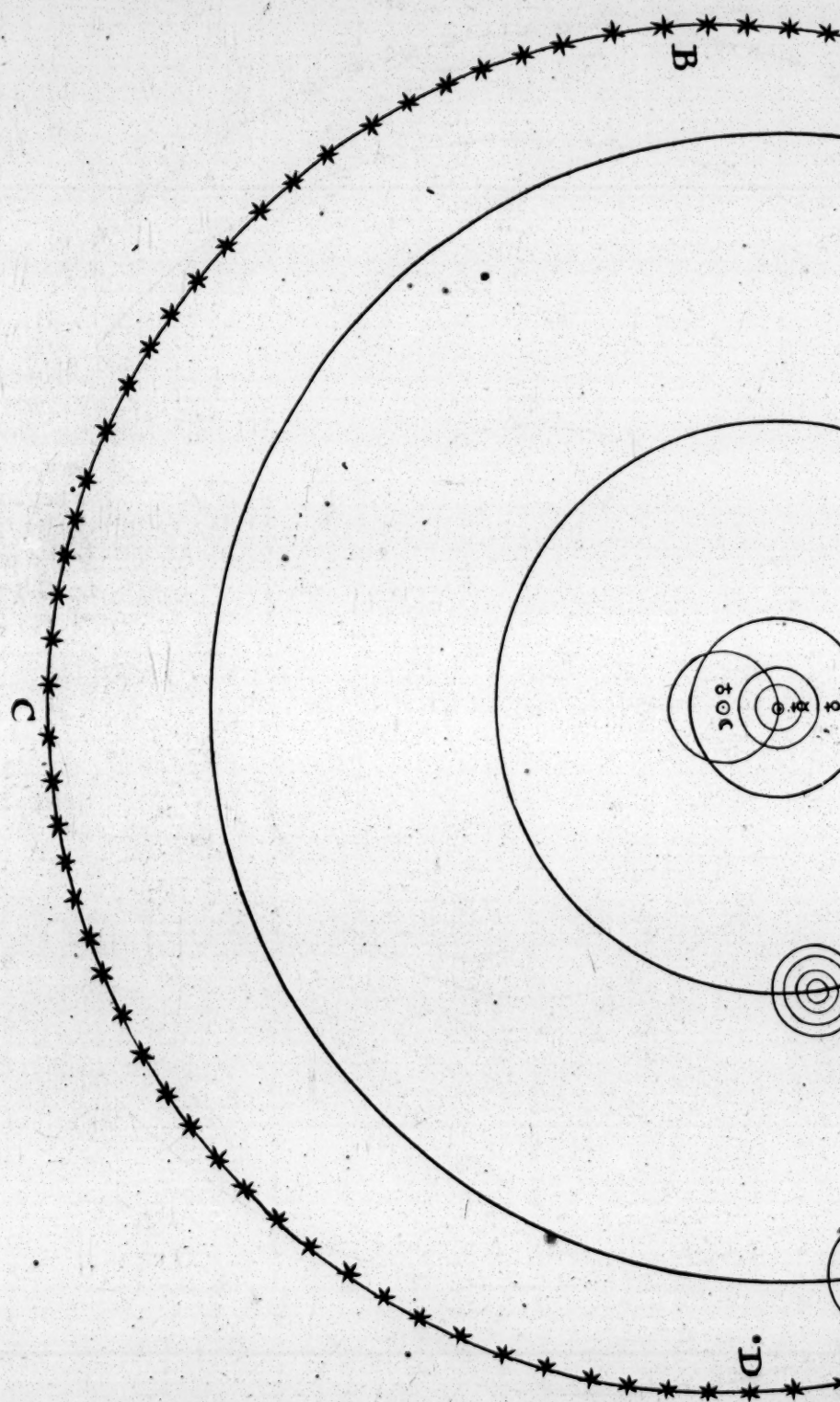
The INTRODUCTION.

can is now generally received by the more learned in *Astronomy*, as the most probable Hypothesis: forasmuch as it not only agrees with the Celestial *Phænomena*, but also explains the Motions

that the *Ptolemaick* Hypothesis was justly liable to, not only revived the old Hypothesis of *Philolaus*, (which Cardinal *Cusa* had moved and defended sometime before him,) but also went so far as to illustrate how the Celestial *Phænomena* might be very well solved thereby; insomuch that this Hypothesis began presently after to be embraced by many, if not by most, of the most Learned *Astronomers*, and from the principal Reviver of it, *Copernicus*, to be called the *Copernican* Hypothesis. The Explication of this takes up great Part of this Treatise. To this belongs *Fig. 1.*

The *Tychonick* Hypothesis is so called from *Tycho Brahe*, a noble *Dan*, who lived in the latter Part of the sixteenth Century, and is famous for his Astronomical Observations at *Uraniburg*, (a Castle built by him in the Island *Weer* or *Huena* in *Denmark*, and by him called by this Name, as importing the *Tower* or *Castle of Heaven*.) This great Person and Astronomer, though he approved of the *Copernican* Hypothesis, in rejecting the *Epicycles*, and other superfluous and erroneous Particulars of the *Ptolemaick* Hypothesis, yet could not reconcile himself to the Motion of the Earth, and the Sun's standing still, both asserted by *Copernicus*. Hereupon he set himself to contrive a new Way for solving the Celestial *Phænomena*, whereby he might avoid what was culpable in the *Ptolemaick* Hypothesis, and yet still retain the Motion of the Sun round the Earth, as round the Center of the World. To this his Hypothesis appertains, *Fig. 3.*

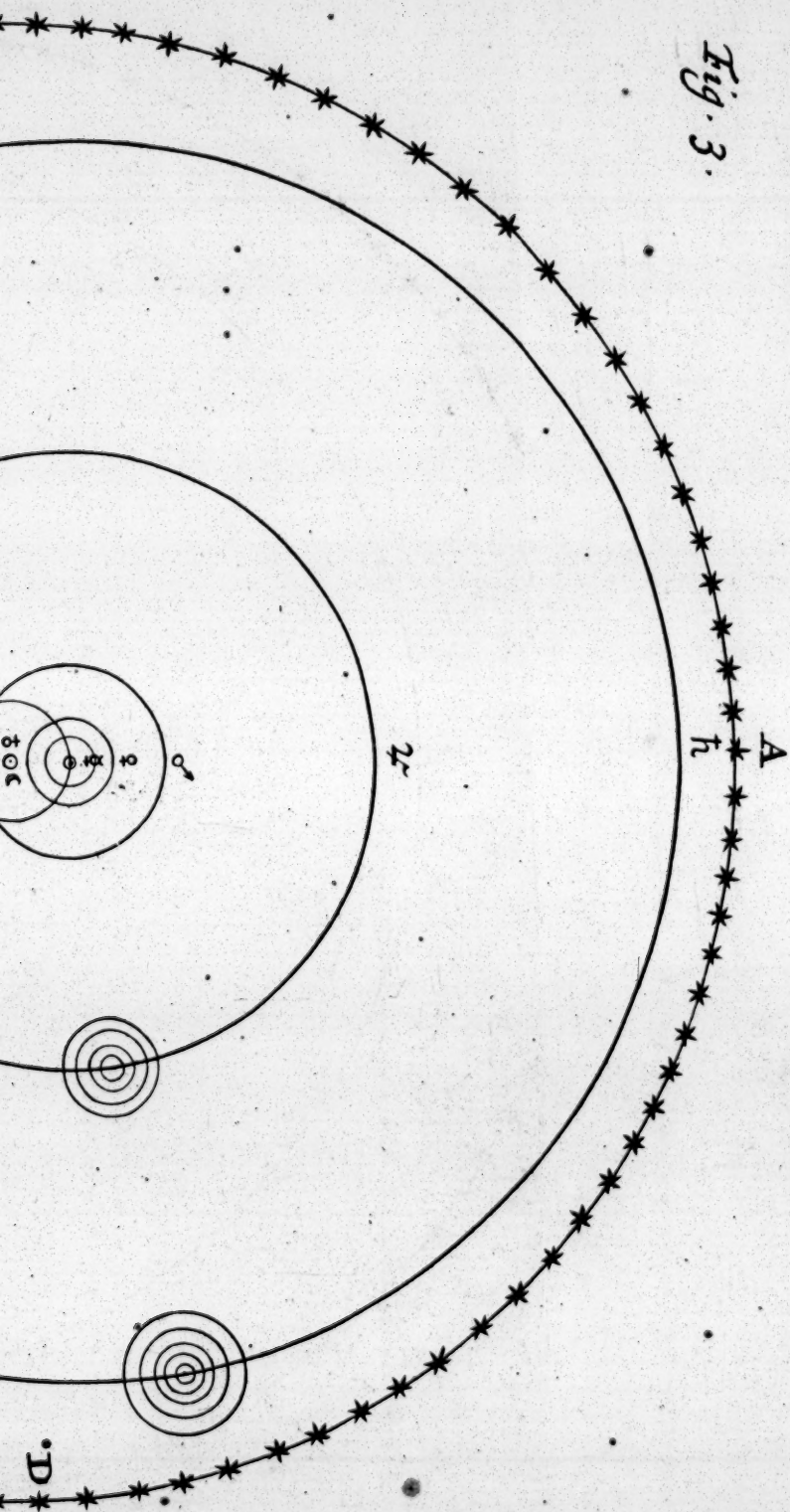
The *Semi-tychonick* Hypothesis is so stiled, as agreeing with the *Tychonick*, excepting only in this, that whereas the

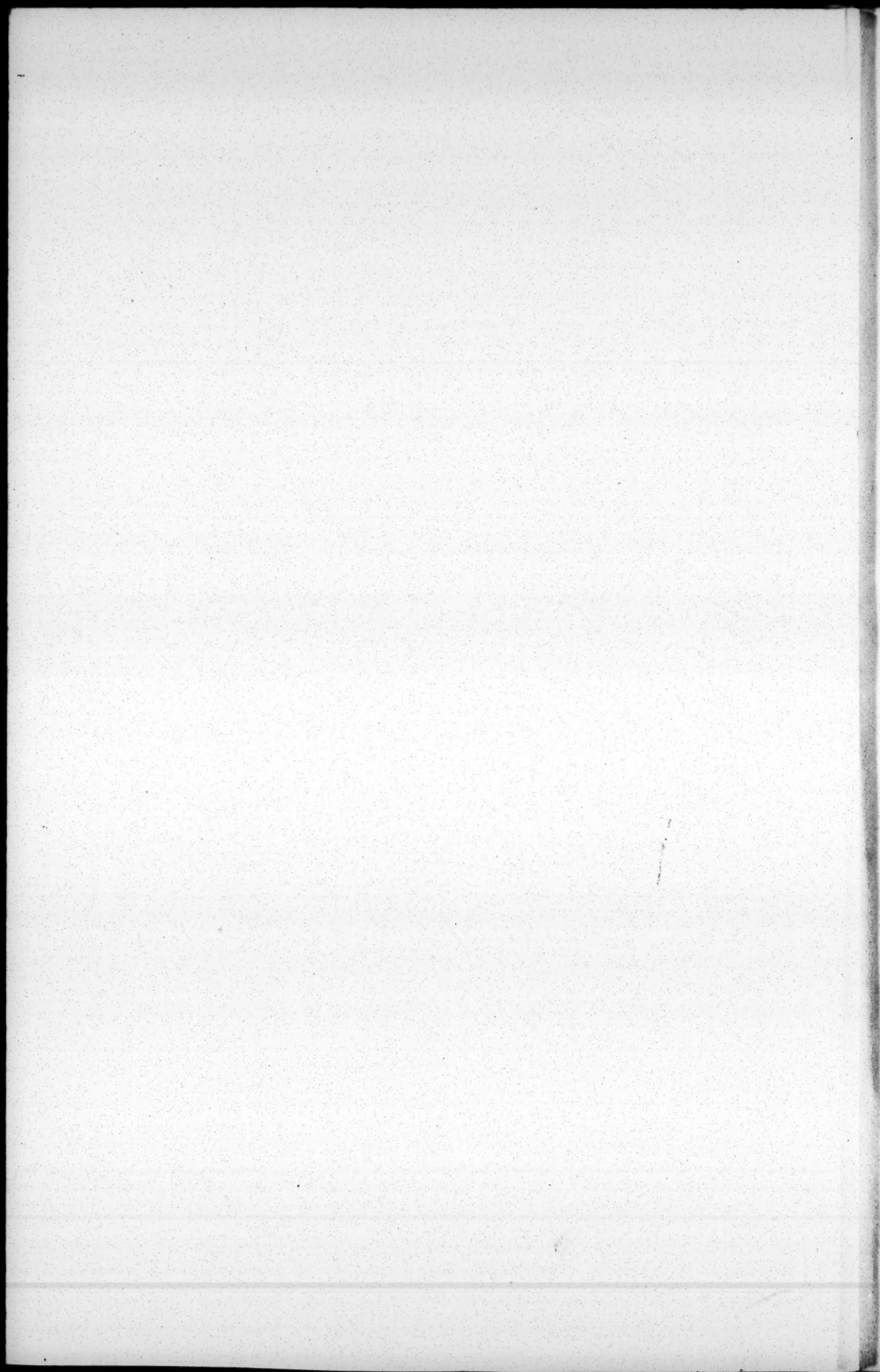


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Astronomy Plate 3.

Fig. 3.





tions whence the said *Phænomena* arise, after the most (*) simple and uniform Manner, and consequently after such a Manner as is most agreeable to the infinite Wisdom of the Creator. I proceed therefore to shew, how the Celestial *Phænomena*, at least the more remarkable of them, may be solved according to this Hypothe-

the *Tychonick* makes the Earth to have no Motion at all, the *Semi-tychonick* makes it to move round its own *Axis*, and so agrees therein with the *Copernican*. But though the *Tychonick* and *Semi-tychonick* Hypothesis were both designed as Corrections of the *Copernican*, yet the Generality of the more Learned in *Astronomy* do still prefer the *Copernican* as the most probable, and that for the Reason above-mentioned in short, and to be more largely insisted on and explained in the Annotations next following.

(*) These two Propositions, viz. *Frustrà sit per plura, quod fieri potest per pauciora*: and *Natura nihil agit frustrà*, being so evident to Reason, as by Logicians and Philosophers to be esteemed *Axioms*, i. e. unquestionable Truths; it hence follows, that That Hypothesis is to be esteemed most agreeable to the Wisdom of God, the Author of Nature, which explains the Motions whence the Celestial *Phænomena* arise, after the most simple (or uncompounded) and uniform Manner; that is, which adjusts the said Motions to the fewest Laws and Principles. But herein the *Copernican* Hypothesis excells all the rest, forasmuch as according thereto, all the Bodies, on whose Motion depend the Celestial *Phænomena*, are retained in their proper *Orbits* by the single Principle of Gravity, and move in their *Orbits* according to one general Rule, or Law of Motion. Of which see more in *Chap. 1.*

fis. And in order hereunto it will be requisite to begin with laying before the Reader the *Copernican* (*) *System*, i. e. in what Order the several Bodies, whereon depend the Celestial *Phænomena*, are placed with Respect one to the other, according to this Hypothesis.

(*) The Word *System* is borrowed from the *Greek* Tongue, wherein it denotes that Frame or Model which arises from placing several Things together, it being a Derivative of the Verb *συνίστημι*, to put, or place together.



C H A P. I.

Of the COPERNICAN SYSTEM in general.

THE *Copernican* System is represented, *Fig. 1.* where the Sun is placed in the Center, and supposed never to move out of it, but only to move therein round its own (*) *Axis*, from West to East, in the Space of about 25 Days. This Motion of the Sun round its *Axis* is inferred from the Observations made of the Spots of the Sun.

Round the Sun, as the Center of their *Orbits*, move six Spherical Bodies in this Order and Time, *viz.* *Mercury* next to the Sun, in about three Months; *Venus* next to *Mercury*, in about seven Months and an Half; after that the *Earth* in a Year; then *Mars* in about two Years; then *Jupiter* in twelve Years; and outermost

C H A P.

I.

I.

I.

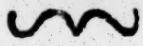
The Place of the Sun.

2.

The Place of Mercury, Venus, the Earth, Mars, Jupiter, and Saturn; and their Periodical Times.

(*) See *Chap. 3. Sect. 5.* and the Note there.

CHAP. of all *Saturn* in about thirty Years.

I. These are respectively denoted, *Fig. 1.*
 by their proper Characters.

3. As the fore-mentioned six Bodies
 of the Moon, and the Satellites of Jupiter and Saturn. move round the *Sun*, so round three of them move other Bodies; viz. round the *Earth* moves the *Moon* in about 27 Days, 8 Hours; round *Jupiter* move four, and round *Saturn* move five Bodies, called respectively the (*) *Satellites* of *Jupiter* and *Saturn*. Of the *Satellites* of *Jupiter*, the innermost moves round *Jupiter* in 1 Day, 18 Hours; the second in 3 Days, and a little more than half a Day; the third in 7 Days, 4 Hours; the fourth and outmost in sixteen Days, 18 Hours. Of the *Satellites* of *Saturn*, the inmost moves round *Saturn* in 1 Day, 21 Hours; the second in 2 Days, 18 Hours; the third in 4 Days, and a little more than half a Day; the fourth in almost 16 Days; and the fifth in 79 Days, 8 Hours.

(*) They are so called, as attending *Jupiter* and *Saturn*, as a Prince is attended by his *Satellites* or Life-guard.

All the Bodies afore-mentioned, except the *Sun*, are called (*) *Planets*, (which Word in the *Greek Language* denotes *Wanderers*) forasmuch as never keeping for any Time the same Distance or Situation one to the other, they may be said to be always Strag-
 CHAP. I.
 4. Planets, why so called, and why distinguished into Primary and Secondary.
 And because the *Moon* and the *Satellites* of *Jupiter* and *Saturn* are Planets of Planets, hence they are distinguished by the Name of *secondary Planets*, and the other six Planets agreeably thereto are distinguished by the Name of *primary Planets*.

The Distance of the primary Planets from the *Sun*, is much the same as is expressed, *Fig. 1*. For dividing the Distance of the Earth from the *Sun* into ten Parts, the Distance of *Mercury* from the *Sun* is almost four such Parts, of *Venus* seven, of *Mars* fifteen, of *Jupiter* fifty-two, and of *Saturn* ninety-five.
 5. The Distance of the primary Planets from the Sun.

(*) Whereas the Planets are commonly reckoned seven, this is according to the *Ptolemaick System*, *Fig. 2*.

And

CHAP. And as to the Distance of the secon-

I. dary Planets from their primary respectively, it is esteemed to be such as this;

6. *viz.* the Distance of the Moon from the Earth to be about 60 Semi-diameters of the Earth. The inmost *Satelles* of *Jupiter* is esteemed to be distant $5\frac{2}{3}$ Semi-diameters of *Jupiter* from the Center of *Jupiter*; the second *Satelles* is esteemed to be distant 9 of the same Semi-diameters; the third $14\frac{1}{3}$ such Semi-diameters; and the fourth $25\frac{1}{3}$ Semi-diameters. In like manner the Distance of the inmost *Satelles* of *Saturn* from the Center of *Saturn* is reckoned to be $4\frac{3}{8}$ Semi-diameters of *Saturn*; the distance of the second to be $5\frac{3}{5}$ such Semi-diameters of the third, 8 Semi-diameters; of the fourth, 18; of the fifth, 54 Semi-diameters of *Saturn*.

7. The Reason of taking such particular Notice of the Distance of the primary Planets from the Sun, and of the secondary Planets from their respective Primary, is this, *viz.* because these several Distances (as well as the several Times, wherein the Planets, whether Primary or Secondary, move round their respective *Orbits*, and which

The Distance of the secondary Planets from their Primary.

The Motion of all the Planets is regulated after an uniform Manner.

which are therefore stiled their *Periodical Times*) are requisite to be known, I. CHAP. I.
 for the apprehending the Excellency of the *Copernican System*; according to which the Motion of all the Planets, both Primary and Secondary, are regulated by one general Law, which is this:

The Squares of the Periodical Times of the { Primary } Planets are one to another, as the Cubes of their Distances from the { Sun. } Center of the Primary.

Thus for Instance as to the primary 8. Planets, the Period of *Saturn* is (*ro-tundè*) 30 Years, of *Jupiter* 12; the Squares of which Numbers are 900 and 144. The Distance of *Saturn* from the Sun is found by Observation to be to the Distance of *Jupiter* from the Sun as about (*) 9 to 5, the Cubes of which are 729 and 125. But the Squares 900 and 144 are very nearly in the same *Ratio*, as the Cubes 729 and 125. And the *Ratio* in this and

The same exemplified as tot' the primary Planets.

(*) Namely the Distance of *Saturn* (as is above, *Seet.* 5. observed) from the Sun is 95, and of *Jupiter* 52, both Distances being measured by the same Measure.

the

CHAP. the following Instances would be

I. found more exact, were the Periods
 and Distances more exactly expressed
 by Numbers. In like manner the Period of the Earth is a little more than four Times greater than the Period of *Mercury*; and so the Squares of the Numbers expressing those Periods will be almost as 17 and 1. And the Distance of the Earth from the Sun being divided into ten Parts, the Distance of *Mercury* from the Sun is found by Observations to be (little less than 4 such Parts, *viz.*) 3 such whole Parts, and 9 Tenths of another, the Cubes of which Numbers (*viz.* 10 and $3\frac{9}{10}$) are 1000 and 59. But it is obvious, that 17 is to 1, much as 1000 to 59. And so of the other primary Planets.

9.
*And also
 as to the
 secondary
 Planets.*

As for the secondary Planets, the Periodical Times of the *Satellites* of *Jupiter* are (as is above, *Seçt.* 3. observed) respectively as $1\frac{3}{4}$, $3\frac{3}{5}$, $7\frac{1}{8}$, and $16\frac{3}{4}$, and their Distances are as $5\frac{2}{3}$, 9, $14\frac{1}{3}$, and 25. But the Square of the Periodical Time of the innermost *Satelles*, namely 3, is to 13 the Square of the Periodical Time of the second *Satelles*, as 170 the Cube of the Distance of
 the

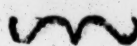
the innermost from the Center of *Jupiter*, to 736 the Cube of the Distance of the second from the same Center. Likewise 3 is to 51 the Square of the Periodical Time of the third *Satelles*, as 170 to 2890 the Cube of the Distance of the third from the Center of *Jupiter*. And again, 3 is to 280 the Square of the Periodical Time of the fourth and outermost *Satelles*, as 170 to 15800 the Cube of the Distance of the said outermost *Satelles* from the Center of *Jupiter*. And the same holds good as to the *Satellites* of *Saturn*. But as to the Moon, it is not applicable to her, forasmuch as she is the only secondary Planet, that moves about the Earth.

From what has been said, evidently appears, that the Periodical Motions of the Planets are performed uniformly, or are regulated by one general Law. And from hence it is demonstrated (*) by the Learned, that the Planets are likewise retained in their

10.
All the
Planets
retained in
their own
Orbits by
Gravity.

(*) See Dr. Gregory (late Savilian Professor at Oxford,) his *Astron. Phys. and Geom. Elem. lib. 1. Prop. 27, 28, 29, and Sect. 6. and 7.* I shall only observe here,

CHAP. their proper *Orbits* after an uniform

I. Manner, by one Sort of Force which  makes them tend to the Center of their respective *Orbits*, and is thence called *the Centripetal Force*, or in one Word, *Gravity*. And this is another Particular, wherein appears the Excellency of the *Copernican System* above any other; forasmuch as this System may be preserved by Gravity alone, uniformly propagated through the Universe; whereas (*) all the other Systems require some (one or more) other Force, besides that of Gravity.

II. All the Planets, Primary and Secondary, are Opacous Bodies, *i. e.* such as have no Light of their own, but receive all their Light from the Sun; and so for this, as well as other Reasons, are accounted as so many Dependants of the Sun. Whence the

All the Planets receive their Light from the Sun.

here, that any Body, when moved, will move uniformly in a straight Line, if not hindered. And agreeably any Planet would fly out of its *Orbit* into a right Line, which is a Tangent to its *Orbit*, was it not hindered or pulled back and retained in its *Orbit* by some Centripetal Force, *i. e.* by Gravity.

(*) See Greg. *Astron. Phys. and Geom. Elem.* pag. 111, 112.

Sun

Sun with these its Dependants make up what is called the *Solar System*, described, *Fig. 1.* CHAP. I.

As for the other Celestial Lights, called the *Fixed Stars*, they are independent of the Sun, as in other Respects, so in respect of Light; forasmuch as they receive not their Light from the Sun, but shine with their own Native Light. Hence they are esteemed to be, not only without this our Solar System, but as so many Suns themselves, each being placed in the Center of some such System, as this our Solar System, and there so *fixed*, as to have no Motion, but round their own *Axis*. They are supposed to be vastly distant from this our Solar System; which is the Reason that their Distance is taken no Notice of in the Description of the *Copernican System*, *Fig. 1.* 12. Of the Fixed Stars.

Besides the Celestial Lights already mentioned, there appear sometimes *Comets*; which is originally a *Greek Word*, denoting in that Language as much as *Hairy*. These Lights are called by the *Greeks*, *Hairy Stars*, because they fancied the Streams of Light, which attend such Stars, to resemble Hair. It is found by Observations, that these *Comets* 13. of Comets.

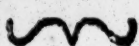
CHAP. mets do (*) pass through the Planetary

I. Orbs of this our Solar System; but
 whether they depend only on the Sun,
 and so belong only to this our Solar
 System, or whether they move in Cir-
 cular or such like Lines, or whether
 they are so much as durable Bodies, is
 not yet discovered. For which Reasons,
 there is no Notice taken of them,
Fig. 1.

14. Before we conclude this Chapter con-
 cerning the *Copernican* System in gene-
 ral, it seems proper to observe, that al-
 though the *Orbits* wherein the Planets
 move, are described, *Fig. 1.* as so ma-
 ny Circles, as may be well enough
 conceived as such in many Respects;
 yet more strictly speaking, they are not
 exactly Circular, but Elliptical. And
 the like is to be understood as to the
Bodies of the *Planets* themselves, *viz.*
 though they are usually call'd in short
 Spherical Bodies, yet exactly speaking
 they are Elliptical or Oval Bodies; such
 as the *Moon* is describ'd in the *Draught*
of the Eclipse, 1715, publish'd by that

The Orbits
 of the Pla-
 nets are
 Elliptical.

(*) Hence the Line the Comet describes by its Motion,
 is called its *Trajectory*.

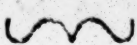
most eminent Astronomer Dr. *Halley*: CHAP.
 From which it appears to what *Acurate* I.
 Skill in Astronomy our Great Professors 
 thereof are now arrived.

Further, it seems not improper to ob-
 serve also here, that the fixed Stars being
 the most remote of all the Celestial
 Lights, and appearing to us as placed in
 one Concave Sphere; hence it is usual
 to denote the *Place* of any of the in-
 termediate Celestial Lights, by assigning
 what Part of the Sphere of the fixed
 Stars they appear to us to be *in*, or
 more properly *under*. And accordingly
 it is usual to distinguish that Tract of
 the Sphere of the fixed Stars, under
 which all the Planets do move, by the
 Asterisms or Constellations that lie in
 that Tract; which being fancied to re-
 present several Things, are therefore
 called *Signs*; and because the Things
 represented by them are most of them
 (*) *Zodia*, or Animals, hence all this
 Tract is stiled the *Zodiack*. Now the
Orbit, wherein the Earth performs its
 Annual Period (and which the Sun seems

15.
Of the Zo-
diack and
Ecliptick.

(*) It is a Greek Word signifying *Animals* or *Living*
Creatures.

CHAP. to move round every Year) runs under

I. the very Middle of the *Zodiack* ; whence
 this middle Part of the *Zodiack* is of
 special Note in *Astronomy*, and is there-
 fore distinguished by a peculiar Name,
 being called the (*) *Ecliptick*. It, as
 well as the whole *Zodiack*, is divided
 into twelve Parts, distinguished by the
 Name of the Constellation or Sign, to
 which each Part was formerly assigned.
 The (†) Names of the said Signs, toge-
 ther with the Characters whereby they
 are denoted in short, are as follows ;
viz.

♈	♉	♊	♋	♌	♍
<i>Aries,</i>	<i>Taurus,</i>	<i>Gemini,</i>	<i>Cancer,</i>	<i>Leo,</i>	<i>Virgo,</i>
♎	♏	♐	♑	♒	♓
<i>Libra,</i>	<i>Scorpio,</i>	<i>Sagittarius,</i>	<i>Capricornus,</i>	<i>Aquarius,</i>	<i>Pisces,</i>

16. *Lastly,* It seems proper here to ob-
 serve, that the Planets do not move in
Orbits, which exactly run one over the
 other, or are all contained in the same

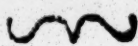
Of the
 Nodes of
 the Pla-
 nets.

(*) The Reason of this Name, See *Chap. 5. Sect.*
 21.

(†) The Names of the Signs are somewhat differently
 expressed in these two memorial Verses, *viz.*

Signa, Aries, Taurus, Gemini, Cancer, Leo, Virgo,
Libraque Scorpius, Arcitenens, Capers, Amphora Pisces,

Plane ;

Plane; but their *Orbits* do all cross one CHAP.
another according to several Degrees of I.
Inclination, or which is the same, the 
Planes of their *Orbits* are variously in-
clined one to the other. Now the
Earth being that Planetary Body we live
on, hence the Plane of the *Orbit* of the
Earth is taken by Astronomers for the
Standard; and the Inclination of the
Planes of the *Orbits* of the other Pla-
nets is reckoned greater or less, as the
said Planes incline more or less in re-
spect to the Plane of the Earth's *Orbit*,
or (*) (which comes to the same) to the
Plane of the *Ecliptick*. The two Points,
wherein the *Orbit* of any Planet crosses
the *Ecliptick*, are called the *Nodes* of
that Planet. And thus much for the
System of the World in general, and
such Particulars as relate to it in general.

(*) For the *Ecliptick* is that Part of the Sphere of the
fixed Stars, which the Plane of the Earth's *Orbit* pro-
duced thereto touches. So that the *Ecliptick* is no other
than the Extremity of the Plane of the Earth's *Orbit*.

C H A P. II.

*Of the DIURNAL PHÆNOMENA common
to the CELESTIAL LIGHTS.*

CHAP. II. **H**AVING in the foregoing Chapter explained, so far forth as is sufficient to the Design of this Treatise, the *Copernican* System in general, I now proceed to explain agreeably thereunto the *Phænomena* of the Celestial Lights. I shall begin with explaining the *Diurnal Phænomena* common to them in general, viz. their Rising, Setting, &c.

The Diurnal Phænomena are common to the Celestial Lights in general

2. Now these *Diurnal Phænomena* of the Celestial Lights may be solved by the *Diurnal Revolution* of the Earth, i. e. by one single Revolution of the Earth round its own *Axis* in 24 Hours. This is illustrated, *Fig. 4.* where the Circle P R T H denotes the Earth; C the Center of the Earth, thro' which is to be conceiv'd to pass perpendicularly its *Axis*, round which it makes its *Diurnal Revolution*. P denotes any Place on the Earth; the Line EW, that

They are to be solved by the Diurnal Revolution of the Earth.

fron

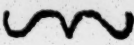
Fig

S

26.

Fi



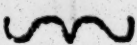
that Circle which bounds the Sight in CHAP.
the said Place, and is by *Astronomers* II.
called the (*) *Horizon*; E the East 
Point of the said *Horizon*; W the
West: the Circle *a b c d e f* denotes
the Circumference of the Heavens;
the Circle S the Sun in the Heavens;
the Semicircle PR T, the enlightened
Hemisphere of the Earth, or that half
of it which is opposite to the Sun;
the Semicircle PH T, the darkened
Hemisphere of the Earth. Now the
Earth being supposed in this Situa-
tion, and also to move round its *Axis*
towards the Sun; it is evident, that
the Place P of the Earth will just be-
gin to be enlightened by the Sun, and
so the Sun will appear there to be just
Rising, or ascending the *Horizon* at E
the East Point of it. The Earth be-
ing moved round its own *Axis*, so as
that the Place P of the Earth, which
afore was under the Point *a* in the
Heavens, now is under the Point *b*;
it is evident, that the *Horizon* of the
said Place P, will be now so situated,
as that the Sun will appear to a Spec-

(*) It is a *Greek* Word, denoting in that Tongue
somewhat that bounds.

CHAP. tator at P, as ascended considerably
 II. above E the East End of the *Horizon*.

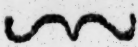
~~~~~ And while, by the Revolution of the Earth round its *Axis*, the Place P passes from under the Point *b* in the Heavens to the Point *c*, the *Horizon* of the Place P will continually sink lower and lower in Respect of the Sun, and so the Sun will appear to ascend higher and higher, till P is come under *c*, where the Sun will appear in its greatest Height above the *Horizon* for that Day; and so it will be Noon or Mid-Day at the Place P. For the Earth moving on, as the Place P passes from under *c* to *d*, the West Point of its *Horizon* will ascend higher and higher, and so the Sun will appear more and more to descend, as is represented by the *Horizon* at the Point of the Earth under *d*. The Place P being carried by the *Diurnal Revolution* of the Earth from under *d* to under *e*, the Sun will then appear just on W the West Point of the *Horizon*, and so will appear to be just Setting. The Place P being come under *f*, it will be then Mid-night there. *Lastly*, the Place P being come round again under *a*, it will be there  
 Sun-



Sun-rising again. And thus it has CHAP.  
 been shewn, that the same *Diurnal* II.  
*Phænomena* of the Sun will come to   
 pass, if the Sun stands still, and the  
 Earth move round its own *Axis* from  
 West to East, or from under *a*, to  
 under *b*, *c*, *d*, &c. in the Heavens ;  
 as are commonly esteemed to come to  
 pass by the Earth's standing still, and  
 the Sun's moving round it from East  
 to West, or from *c* to *b*, *a*, *f*, &c.  
 And that the same holds good as to  
 any other Celestial Light, and the  
 Earth, is obvious to shew from *Fig. 4.*  
 the Circle representing the Sun being  
 taken to denote any other Celestial  
 Light.

But now it being justly received by 3.  
 Philosophers as an unquestionable Truth, The Pro-  
 bability of  
 the Coper-  
 nican Sys-  
 tem further  
 established.  
 that *Nature works after the most simple*  
*and compendious Manner* ; it thence fol-  
 lows, that the Solution of the *Diurnal*  
*Phænomena* by the Revolution of the  
*Earth alone* round its own *Axis*, is much  
 more agreeable to Nature, than the So-  
 lution of the said *Phænomena* by the  
 Revolution of *all the several Celestial*  
*Lights* round the Earth.

CHAP. It remains only to observe, that

II. whereas by the *Diurnal Revolution* of  
 the Earth, all the several Celestial

4. Lights seem to move in the Heavens  
 The com-  
 mon and  
 proper  
 Motion of  
 the Celesti-  
 al Lights,  
 what.  
 from East to West, hence this seeming  
*Diurnal Motion* of the Celestial Lights  
 is called their (\*) *common Motion*, as  
 being common to all of them. Be-  
 sides which all the Celestial Lights,

but the Sun, have a *proper Motion*;  
 from which arise their proper *Phæno-  
 mena*. As for the proper *Phænomena*  
 of the Sun, they likewise seem to arise  
 from the proper Motion of the Sun,  
 but are really produced by another Mo-  
 tion which the Earth has, and whereby  
 it moves round the Sun once every Year,  
 whence it's called the *Annual Motion*

---

(\*) The *Diurnal Motion* is also called *Motus Primus*,  
 either because it is usually *first* treated of, or else because  
 it is supposed according to the Vulgar or *Ptolemaick Sys-  
 tem* to be caused by the *Primum Mobile*, which accord-  
 ing to the said System is a Sphere above the fixed Stars,  
 carrying all the Celestial Lights along with it from  
 East to West. Whence the said *Diurnal Motion* is also  
 called sometimes *Motus Raptus*, In like manner the  
*proper Motion* is otherwise stiled *Motus Secundus*, in  
 Contradistinction to the *Diurnal Motion*, called *Motus  
 Primus*.

of

of the Earth. Having therefore ex-CHAP.  
plained in this Chapter the *Diurnal* II.  
and common *Phænomena* of the Cele-  
stial Lights, I proceed to explain their  
proper *Phænomena*.





## C H A P. III.

*Of the PHÆNOMENA (commonly ascribed to the seeming Annual Motion of the SUN, but rather) depending on the real Annual Motion of the EARTH.*

CHAP.  
III.

**B**Eing to explain in the next Place the *Phænomena* proper to the several Celestial Lights, I begin with the proper *Phænomena* of the *Sun*; forasmuch as the *Sun* is the principal Light of that System of the World, wherein we are placed.

I.  
*The proper Phænomena of the Sun, why first explained.*

Now these *Phænomena* of the *Sun*, which are vulgarly ascribed to the seeming *Annual* Motion of the *Sun*, may be solved by the *Annual* Motion of the *Earth*. In order whereunto it is first to be shewn, that the *Annual* Motion of the *Earth* will cause the *Sun* to appear to us, as if it had such an *Annual* Motion, though it really has no such Motion. And this is illustrated, *Fig. 5*, where the *Sun* is in the

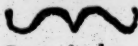
2.  
*The seeming Proper or Annual Motion of the Sun is caused by the real Annual Motion of the Earth.*

the Center; the Circle next round it CHAP. denotes the *Orbit* of the Earth, or III. that Circular Line which the Center of the Earth describes by its Annual Motion; the outermost Circle denotes the *Ecliptick*, distinguished into its 12 Parts or Signs. Now supposing the Earth to be at A, the *Sun* will appear to us to be at  $\alpha$ ; and supposing the Earth to move from A to B, and so to C, the *Sun* will thereby appear to us to move from  $\alpha$  to  $\mu$ , and thence to  $\gamma$ . And in like manner, by the Earth's Motion along the Rest of its own *Orbit* till it comes to A again, the *Sun* will seem to us to move along the Rest of the *Ecliptick* till it comes to  $\alpha$  again. 'Tis evident then, that, supposing the Earth to move as has been here described, the *Sun*, though it really stands still, will seem to have the same *Annual* Motion along the *Ecliptick*, as it would have, if it really moved so, and the Earth stood still.

Only 'tis remarkable, that whereas we commonly say, *the Sun is in  $\alpha$  or Libra*, when it is between us and *Libra*, (and so of any other Sign,) if we would speak properly, and agreeably to the natural

3.  
An Obser-  
vation as  
to the com-  
mon Way  
of saying,  
that the

CHAP. natural Cause of this and such like)

III. *Phænomenon*, we should say, that *the*  
 *Earth is then in ♈ or Aries*; forasmuch  
 as the *Earth* in its real Motion is always  
 in the Point of the *Ecliptick* opposite  
 to that, wherein the *Sun* appears to  
 be.

4. Having shewn that the *Annual* Mo-  
 tion of the *Earth* along the *Ecliptick*  
 will make the *Sun* appear to us, as if it  
 had such an *Annual* Motion; I pro-  
 ceed now to shew, how the Variety of  
 Days and Nights as to their Length,  
 and the various Seasons of the Year,  
 (all commonly ascribed to the seem-  
 ing *Annual* Motion of the *Sun*,) may  
 be solved by the *Annual* Motion of the  
*Earth*. And this is illustrated *Fig. 6*;  
 for the clearer Understanding whereof  
 there are to be premised the following  
 Particulars.

5. As the (\*) *Axis* of the *Earth* (and  
 so of the *Sun*, or any other Celestial  
 Body) is the very Mid-line of it,  
 which consequently passes through its  
 Center, and is represented, *Fig. 6*,  
 of the  
 Equator,  
 its Axis  
 and Poles;  
 as also of  
 the Tro-  
 pics,

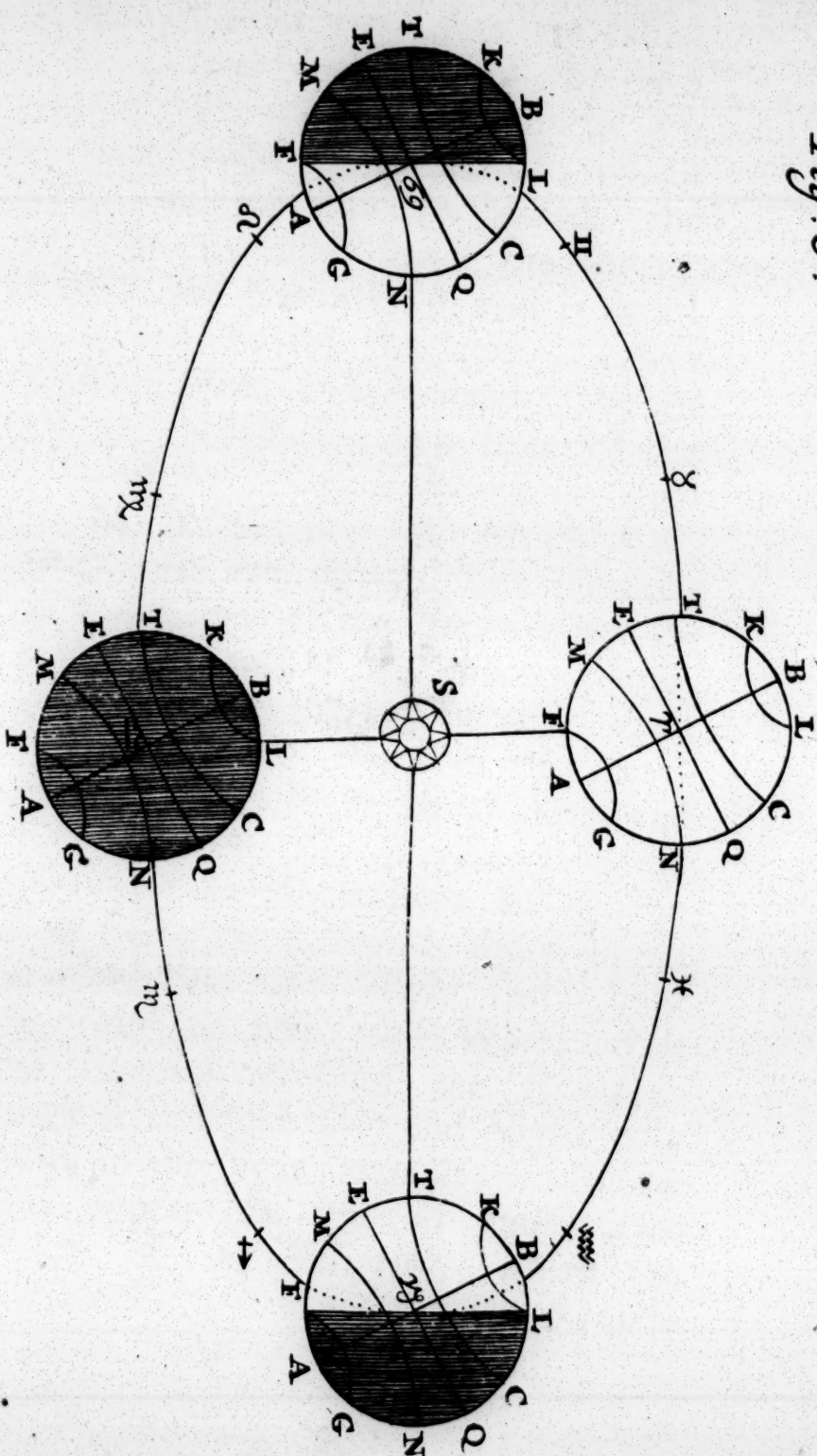
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(\*) The right Line, round which Bodies or Circles  
 are conceived to move, are so called in Allusion to the  
*Axis* or Axle-tree of a Chariot or Cart-wheel.

(where

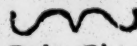


*Astronomy Plate 5.*  
*Fig: 6.*



*Place this facing Pag. 28.*



(where the Circle A Q B E represents CHAP. the Earth,) by the right Line A B; so III.  
the two Ends of any *Axis* are called   
its *Poles*, and consequently the two <sup>Polar Cir-</sup>  
Ends of the *Axis* of the Earth are <sup>cles, Equi-</sup>  
called the *Poles* of the Earth; which <sup>noctial</sup>  
always pointing one Northwards, the <sup>Points,</sup>  
other Southwards, hence the former <sup>Solstitial</sup>  
is called the *North Pole*, and is deno- <sup>Points,</sup>  
ted, *Fig. 6*, by B; the latter is called <sup>&c.</sup>  
the *South Pole*, and is denoted by A.  
Between these Poles each Point of the  
Earth by its *Diurnal Revolution* does  
describe a Circle; of which that,  
which is in the very Middle between  
the Poles, and is the greatest, is cal-  
led the *Equinoctial* or *Equator*, (deno-  
ted *Fig. 6*, by E Q,) because when  
the *Sun* is in the Plane of this *Equi-*  
*noctial* Circle, it is equal Day and  
Night all over the World. And did  
this Circle exactly answer to, or run  
along under the *Ecliptick*, there would  
be equal Day and Night throughout  
the Year all over the World. But  
the Equator crossing the *Ecliptick*,  
hence it is equal Day and Night only  
twice in the Year, namely, when the  
*Sun* appears in one of those two  
Points of the *Ecliptick*, where the  
*Equator*



CHAP. *Equator* crosses it, viz. in the first

III. Degree of *Aries*, and the first of *Libra*; which are therefore called the two *Equinoctial Points*; and the Times of the Year answering thereto, the two *Equinox's*, one the *Vernal*, the other the *Autumnal*. Among the other Circles, which the several Points of the Earth by its *Diurnal Revolution* describe between the two Poles of the Earth, and which are all parallel to the *Equator*, there are four more remarkable, the two *Tropicks*, and the two *Polar Circles*. The two *Tropicks* are those Circles on the Earth, which the *Sun* seems to go directly over, when it is at its greatest *Declination* or Distance from the *Equator*, either Northward or Southward. Whence one is called the *Northern Tropick*, the other the *Southern*. And because when the *Sun* appears to move vertically over the *Northern Tropick*, he appears also to be in the Beginning of *Cancer*, hence the said *Tropick* is frequently stiled the *Tropick of Cancer*; and for the like Reason the *Southern* is otherwise stiled the *Tropick of Capricorn*. The Reason why both these Circles are called *Tropicks*,

picks, is because the *Sun* appearing CHAP. then at his greatest respective (Nor- III.thern or Southern ) Declination or Distance from the *Equator*, begins from thence presently to (\*) *turn back again* towards the *Equator*. And because the *Sun* in the first Degree of *Cancer* and *Capricorn* does as it were make a Stand, going neither Northward nor Southward further from the *Equator*, hence these two Points of the *Ecliptick* are called the two *Solstitial Points*; and these two Times of the Year are called the two *Solstices*, one the *Summer*, the other the *Winter*. The *Tropick* of *Cancer* is represented, Fig. 6. by the circular Line T C, the *Tropick* of *Capricorn* by M N. The two *Polar Circles* are so called, either as being near to the two *Poles* of the *Equator*, or because they on the Earth (†) answer to those Circles in the Heavens,

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(\*) The Greek Verb *τρέπω* signifies to *turn*; whence is derived *τροπικός* denoting somewhat from whence a *Turn* is made.

(†) As every Point of the Earth by its real *Diurnal Revolution*, does *really* describe a Circle between the two *Poles* of the Earth; so the *Sun*, by its seeming *Diurnal Revolution*, does seemingly describe every Day a Circle,

CHAP. Heavens, which the (\*) *Poles* of the  
 III. *Ecliptick* seem to describe by the ap-  
 parent *Diurnal* Motion of the Hea-  
 vens. Hence these *Polar* Circles are  
 just as far distant from their respec-  
 tive *Poles* of the *Equinoctial*, as are  
 the *Tropicks* from the *Equinoctial*, viz.  
 $23\frac{1}{2}$  Degrees, this being the Measure  
 of the Angle, which the Planes of the  
*Equator* and *Ecliptick* make by their  
 mutual Inclination. These *Polar* Cir-  
 cles do bound those Tracts of the  
 Earth, where it is Day or Night du-  
 ring more or fewer whole *Diurnal*  
*Revolutions* of the Earth, or for 24

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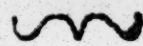
Circle, directly answering in the Heavens to that Circle on the Earth, to which the *Sun* is that Day Vertical. Hence there are usually conceived in the Heavens, *Equinoctial* and *Tropical* Circles, which directly answer to the like *Terrestrial* Circles.

(\*) As the Earth, Sun, and all the other Celestial Bodies are said to have their respective *Axes*; so the Astronomical Circles, (viz. *Ecliptick*, *Horizon*, &c.) are conceived by Astronomers to have their respective *Axes*; each of which is conceived to be a right Line passing through the Center of the said Circles, so as to be perpendicular to their respective Planes: And the Extremities of any such *Axis* is likewise called the *Pole* of the Circle, to which the said *Axis* belongs. And consequently (the *Axis* being always perpendicular to the Plane) the *Poles* of any Circle are always distant, each 90 Degrees from the said Circle.

Hours



Hours and upwards together. Of CHAP. III.  
these *Polar* Circles, one is termed the

(\*) *Arctick* or northern Polar Circle,  as being nigh the *Arctick* or North Pole of the *Equator*, and the other for the like Reason is termed the *Antarctick* or southern Polar Circle. The former is denoted, *Fig. 6*, by the circular Line *KL*, the latter by *FG*. It only remains to observe, that the *Sun* (or any other Celestial Light) will appear to be vertical to that Point of the Earth, where a right Line drawn from the Center of the *Sun* (or other Celestial Light) to the Center of the Earth, crosses the Surface of the Earth. Thus, *Fig. 6*, when the Earth is in the Beginning of *Capricorn* or at  $\varpi$ , the *Sun* will appear to be vertical to the northern Terrestrial *Tropick* or *TC*, because a right Line drawn from *S* to  $\varpi$ , will cross the Surface of the Earth at *T*. So when the Earth is at  $\gamma$ , the *Sun* will appear vertical

---

(\*) The north Pole of the *Equator* is called otherwise the *Arctick*, because it is near the Constellations called the great and little Bears; the Greek Word *ἄρκτος* signifying a Bear; and hence the southern Pole is named the *Antarctick*, as being opposite to the *Arctick*.

CHAP. to the Terrestrial *Equator* or E Q,  
 III. because a right Line drawn from S to  
 √ will cross the Surface of the Earth  
 in a Point of E Q; for in this Posi-  
 tion of the Earth the Line S √ is  
 to be conceived perpendicular to the  
*Axis* A B. These Particulars being  
 premised and apprehended, it will be  
 easy to apprehend how the various  
 Length of Day and Night, and the  
 various Seasons of the Year are pro-  
 duced by the *Annual* Motion of the  
 Earth.

6. Suppose then the Earth to be at ∞,  
 the *Sun* (as is afore observed, *Sect.*  
 3.) will appear at √, and so in one  
 of the *Equinoctial* Points, and in the  
 Middle between the Poles of the  
 Earth A and B; and consequently  
 will enlighten from Pole to Pole,  
 that Hemisphere of the Earth which  
 is opposite to it. Whence Half of  
 the Terrestrial *Equator* E Q, and of  
 every Circle parallel thereunto, will  
 at that Time be enlightened by the  
*Sun*, and Half will be in the Dark.  
 And consequently every Place on the  
 Earth (forasmuch as it lies either in  
 the Terrestrial *Equator*, or some Pa-  
 rallel to it) being carried round the  
*Axis*,

*The Ver-  
 nal Equi-  
 nox ex-  
 plained by  
 the Annual  
 Motion of  
 the Earth.*

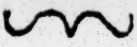
*Axis*, of the Earth in an uniform Man-  
ner by the *Diurnal* Motion of the  
Earth, will be as long in the Light,  
as in the Dark, *i. e.* the Day and  
Night will be then *equal* all over the  
Earth.

The Earth being moved by its *An-*  
*nual* Motion from  $\sphericalangle$  to  $\varpi$ , the *Sun*  
appears then to us to be in  $\ominus$ , where  
is its greatest Declination northward.  
And the *Sun* being in this Situation,  
'tis evident, that the Rays of the *Sun*  
which enlighten one Half of the  
Globe of the Earth at a Time, reach  
beyond the north Pole B to L, and  
at the south Pole reach no further  
than F. Whence it follows, that the  
Tract of the Earth within the north  
*Polar* Circle K L, at this Time of the  
Year enjoys Day-light throughout  
the whole *Diurnal Revolution* of the  
Earth; and on the contrary, that it is  
continual Night throughout the whole  
*Diurnal Revolution* of the Earth, in the  
Tract of the Earth lying within the  
south *Polar* Circle FG. It follows also,  
that the greater Portions of the Pa-  
rallels to the *Equator*, which lie be-  
tween the *Equator* and northern *Polar*  
D 2 Circle,

7.

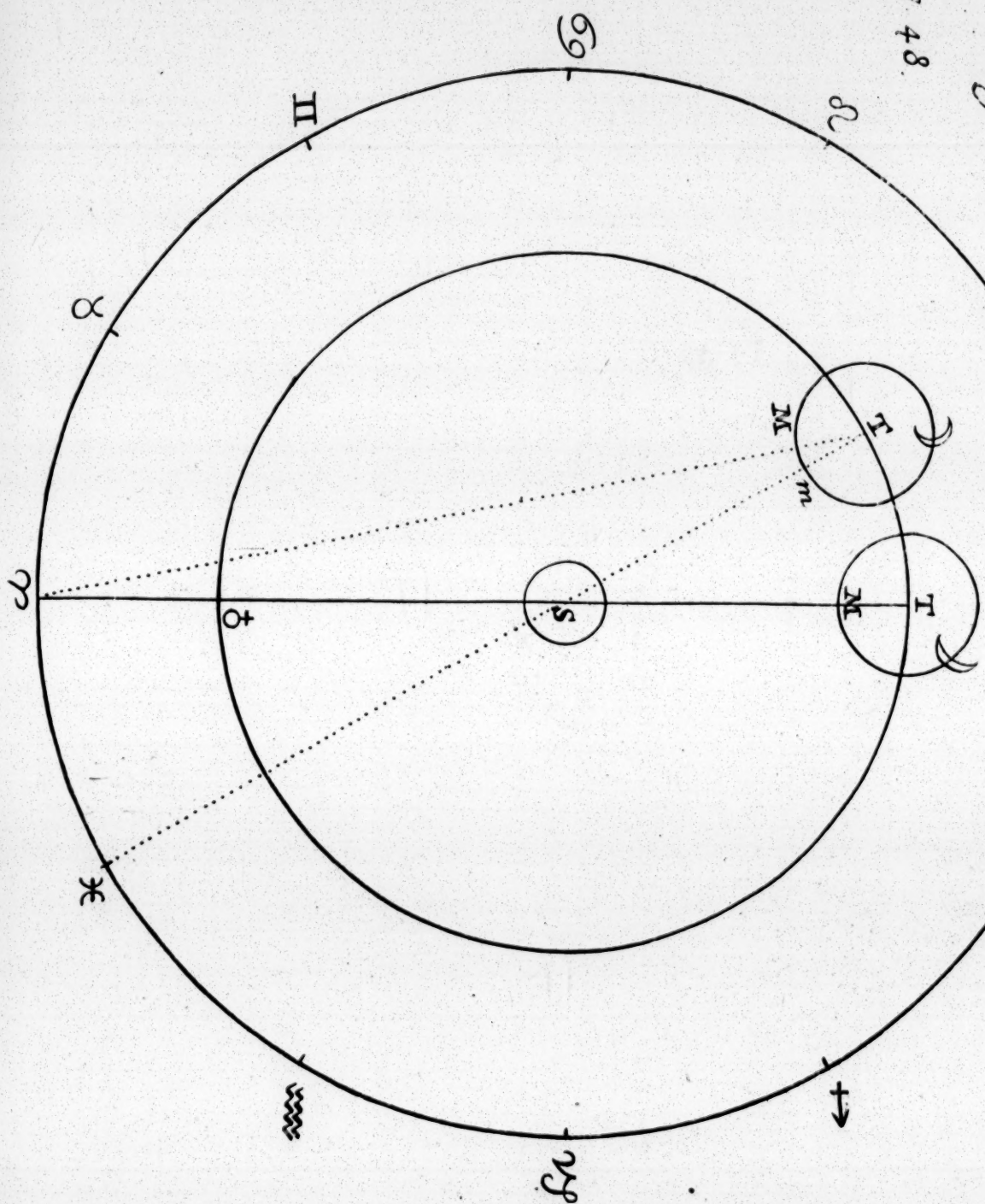
*The Reason of the Days being longest at the Summer Solstice.*



CHAP. Circle, have the Light of the *Sun*; but  
III. the greater Portions of such Parallels,  
 as lie between the *Equator* and southern  
*Polar* Circle, have not the Light of  
the *Sun*; and the Portion of the Pa-  
rallel, which is or is not enlightened,  
is so much the greater or lesser, as the  
Parallel is more or less distant from the  
*Equator*, there being exactly one Half  
of the *Equator* always enlightened, and  
the other not. And hence it is, that  
in this Position of the Earth in the  
first of *Capricorn*, when the *Sun* seems  
to be in the opposite, *viz.* first Degree  
of *Cancer*, the Days are longest in the  
northern Parts of the Earth, and the  
Nights shortest, and so it is Summer  
there. Whereas in the southern Parts  
of the Earth, the Days are then short-  
est, and the Nights longest, and so it  
is there Winter. And the longest Day  
is so much the longer, as the Place  
is more remote from the *Equator*. But  
to such as live on the Terrestrial *E-*  
*quator* it self, Day and Night are now,  
and throughout the whole Year, equal  
one to the other, for the Reason above-  
mentioned.

The







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Astronomy Plate 6.

Fig. 7.

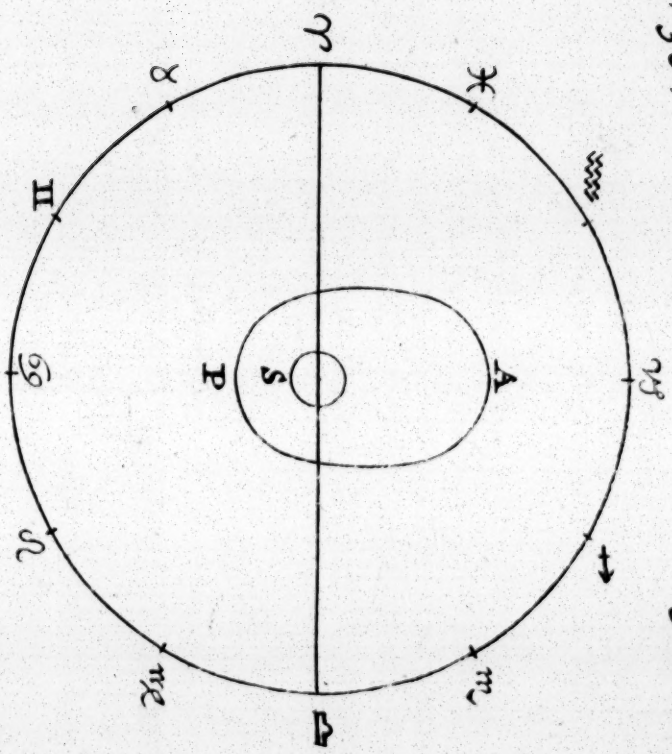
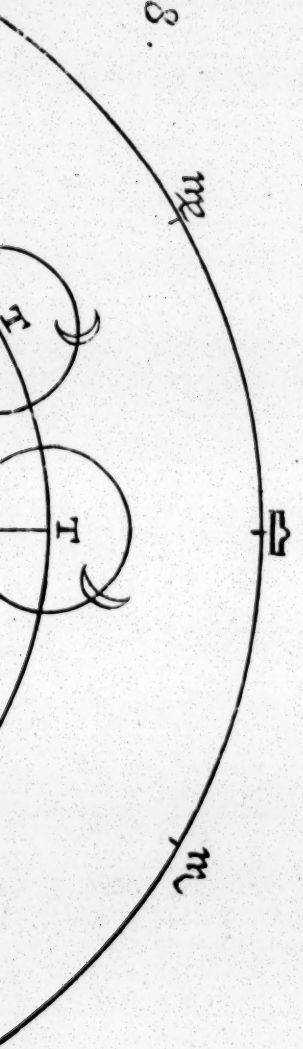
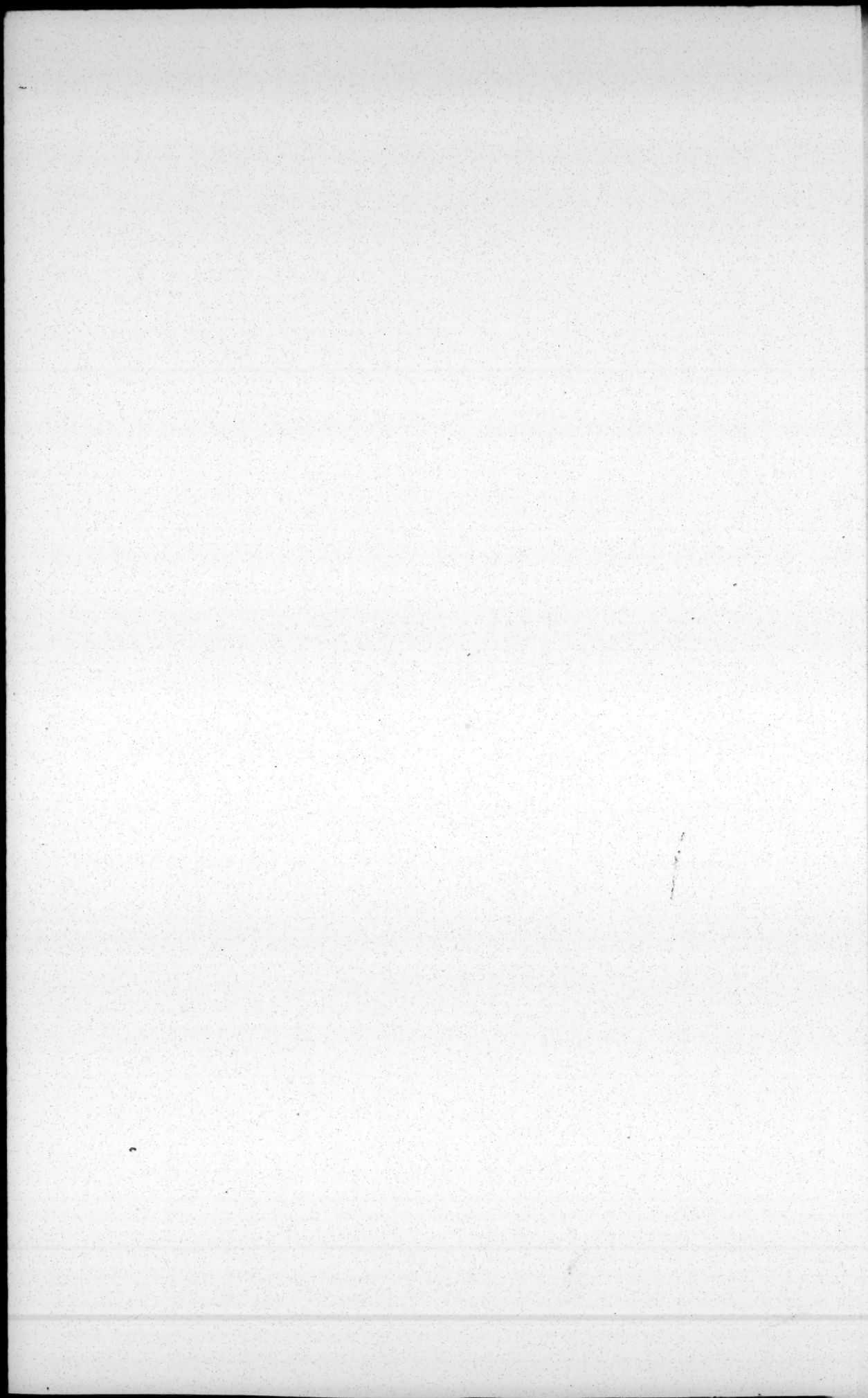


Fig. 8.





The Earth moving from ♄ to ♋, CHAP. the *Sun* will seem to move from ☿ to III. ☿, and so will appear in the Celestial Equator, and make Day and Night 8. equal, as when the Earth was at the opposite Point ☿, for the like Reasons. In like manner the Earth moving from ♋ to ☿, the *Sun* will seem to move from ☿ to ♄, where it is in its greatest southern Declination. And consequently at this Time of the Year, the like *Phænomena* will happen to the Inhabitants of the southern Hemisphere of the Earth, as happened to those of the northern Hemisphere, when the Earth was in ♄; and the like *Phænomena* will be in the northern Hemisphere, as were afore in the Southern.

*The Autumnal Equinox, and the Reason of the Days being shortest at the Winter Solstice, explained.*

Having thus shewn, that the same 9. *Phænomena*, as to the Length of Day and Night, and so as to the various Seasons of the Year, will arise from the *Annual Motion* of the *Earth* round the *Ecliptick*, as from that of the *Sun*, at the four Cardinal Points of the *Ecliptick*, viz. the two *Equinoctial*, and the two *Solstitial* Points; it is obvious, that the same *Phænomena* will likewise happen at any the intermedi-

*The Solution of the like respective Phænomena at the intermediate Points of the Ecliptick, is easily to be inferred from what has been said.*



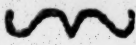
CHAP. *ate* Points of the *Ecliptick*, from the  
 III. Motion of the one as well as of the  
 ~~~~~ other, as to the Increase and Decrease of  
 Day and Night, and consequently as to
 the Difference of Seasons.

IO. As the *different Length* of Day and
 Night, and the different Seasons at
 different Times of the Year are *Phæ-*
of the *Distance* *of the Sun* *from the* *Earth, its* *seeming* *different* *Magni-* *tude, and* *different* *Rate of* *Motion.* *nomena*, which escape no one's Obser-
 vation, and have been already ac-
 counted for; so there are other *Phæ-*
nomena of the *Sun*, which are not so
 easily to be observed, and therefore
 are taken Notice of only by the more
 curious in these Matters. Such is the
different Distance of the *Sun* from the
 Earth at different Parts of the Year;
 as also its appearing of a *different*
Magnitude, and its seeming to move
 at a *different Rate*. For as the *Sun's*
 Diameter appears lesser about the
 Middle of *June*, and greater about
 the Middle of *December*, so the *Sun* is
 more distant from us in our Summer,
 than in our Winter; and also seems
 to move slower in the former, than
 in the latter; insomuch that it takes
 up about eight Days more in its seem-
 ing to pass from the Vernal to the
Autumnal Equinox, than in its seem-
 ing

ing to pass from the *Autumnal* to the *Vernal*; although in both Intervals of Time it seems to pass over but an equal Portion of the *Ecliptick*, namely, just Half. These *Phænomena* of the *Sun*, as they depend one on the other, so may be all solved by the *Annual* Motion of the Earth, in an *Elliptical Orbit*, round the *Sun* placed in one of the (*) Focus's of the Ellipsis, as is illustrated, *Fig 7.* where the Circle represents the *Ecliptick*, the Ellipsis represents the *Orbit* of the Earth, S the *Sun* placed in one of the Focus's of the said Ellipsis. Now about the Middle of *June* the *Sun* appears to us in the Beginning of *Cancer*, and consequently the Earth is in the Beginning of *Capricorn*, and so at the Point A of its *Elliptical Orbit*, that is, at its (†) *Aphelium* or greatest Distance from the *Sun*; whence the
Sun

(*) In *Fig. 6.* the *Sun* is placed in the Center, not one of the Focus's, only for more Convenience sake in drawing the Figure. It may be easily conceived to be in the Focus next to the Sign of ♋, where it ought to be strictly.

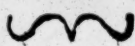
(†) What is here called the *Aphelium* and *Perihelium*, is by such, as follow the Hypothesis of the *Sun's*

CHAP. *Sun* appears then less to us. About
 III. the Middle of *December*, the *Sun* ap-
 appears to us in the Beginning of *Capri-*
corn, and consequently the Earth is
 then in the Beginning of *Cancer*, that
 is, at the Point P of its *Elliptical Or-*
bit, and so at its *Perihelium*, or least
 Distance from the *Sun*; which there-
 fore appears to us then greater. Fur-
 ther, as the Line drawn from γ to $\simeq$
 through the Center of the *Sun* S, di-
 vides the *Ecliptick* into two halves, so
 it unequally divides the *Orbit* of the
 Earth; the greater Segment whereof
 answers to the six Signs of the *Eclip-*
tick, which the Earth passes under be-
 tween the Vernal and Autumnal *Equi-*
nox; and the lesser Segment answers to
 the other six Signs of the *Ecliptick*,

real *Annual* Motion, called the *Apogee* and *Perigee*; and
 these suppose the *Sun* to move *Annually* round the Earth
 in an *Eccentric* Circle, which comes much to the
 same as an *Elliptical Orbit*. The *Aphelium* and *Perihe-*
lium are not always in the same Points of the *Eclip-*
tick; but move a little and a little forwards according
 to the Series of the Signs. The former is at present
 reckoned about the 7th Degree of *Capricorn*, and the
 latter about the 7th Degree of *Cancer*. They are both
 Words derived from the *Greek Language*, and therein of
 the Importance above specified.

which

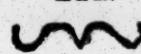
which the Earth passes under between CHAP.
the Autumnal and Vernal *Equinox*. III.

Whence it comes to pass, that the 
Earth taking up more Time to go a-
long the greater Segment of its Orb,
than the lesser, the *Sun* seems to take
up more Time, and consequently to
move more slowly, in passing along the
fix Signs of the *Ecliptick*, which it
seems to pass through between the Ver-
nal and Autumnal *Equinox*, than it
does in passing along the other fix Signs
of the *Ecliptick*, which it seem to pass
through between the Autumnal and Ver-
nal *Equinox*.

As the Time of the Earth's *Annual* II.
Motion from any Point of the *Ecliptick* The Time
of the
Earth's
Annual
Motion, or
of the So-
lar Year.
to the same again, is computed 365
Days, 5 Hours, and 49 Minutes; so
the Time of the Earth's Motion from
the Vernal to the Autumnal *Equinox*, is
computed 186 Days, besides some odd
Hours and Minutes; and from the Au-
tumnal *Equinox* to the Vernal 178
Days, besides some odd Hours and Mi-
nutes. So that the Difference between
these two Intervals of Time is (as a-
fore has been observed) about eight
Days.

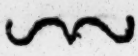
But

CHAP. But there are two Difficulties, which
 III. are to be removed. One is in reference

 to what has been said concerning the

12. *Sun's* being more distant from the
 The Sun, Earth in Summer than in Winter. For
 why hotter since the *Sun* is the Fountain of Heat
 to us in as well as Light to the Earth, it may
 Summer, be asked, how it comes to pass, that
 though the *Sun* is *hotter* to us in Summer than
 farther in Winter; if so be it be *further* from
 from us. us in the former than in the latter.

Now this Difficulty will be removed, by considering, that the *Sun* (or any other Body of Fire) feels more or less hot to us, not only as it is nearer or further from us, but also as its Rays come more or less directly to us. Whence though the *Sun* be farther from us in Summer than in Winter, yet because its Rays are much more nearly perpendicular to us in the former than in the latter, therefore it is hotter to us in the former than in the latter Season. That the Rays of the *Sun* fall more nearly perpendicular, or more directly upon us in the Summer than in Winter, is obvious to infer from *Fig. 6.* For when in Summer the Earth is in the Beginning of ϖ , and consequently

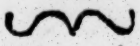
ly the *Sun* appears to be in the Begin- CHAP.
ning of ☿, the *Sun* is then in a per- III.
pendicular Line to T, or the Rays of 
the *Sun* then fall perpendicularly on
the Terrestrial *Tropick* TC; and there-
fore, although the Earth be about that
Time in its *Aphelium* or greatest Dis-
tance from the *Sun*, yet the *Sun* is
then hottest to us in these Parts of the
Earth north of the said *Tropick*. But
as the Earth moves from the Beginning
of ♄ toward ♀ and ☿, so the Perpen-
dicular from the *Sun* to the Earth
moves from T towards MN the south-
ern *Tropick*, so that the *Sun* is exactly
perpendicular to MN when the Earth
is in the first of ☿, or at the Winter
Solstice. Wherefore, although the Earth
be about that Time in its *Perihelium* or
least Distance from the *Sun*, yet the
Sun is not then so hot to us, because
its Rays fall more obliquely, as is evi-
dent by supposing a right Line drawn
from the *Sun* to the Point T in that
Position of the Earth at ☿.

The other Difficulty is in reference
to the *Annual* Motion of the Earth
round its *Orbit*. For such a Motion
seems inconsistent with the Earth's
retaining

13.

The
Change of
the Earth's
Place in
its Annual

CHAP. retaining always the same Situation in

III. Respect to the fixed Stars. But it is
 to be known, that the Circle of the
 Orbit, *why* Earth's *Orbit* is so very little in Respect
it makes of the Sphere of the fixed Stars, that
no sensible Change as the Earth's changing its Place in the
 to the said *Orbit* by its *Annual* Motion, makes
 Earth's Si- no sensible Change of the Earth's Si-
 tuation in respect of the fixed Stars.

In whatever Point of her *Annual Orbit*
 the Earth is, its *Axis* and *Equator* (be-
 ing each every where parallel to itself)
 will, if produced, fall on the same fix-
 ed Stars as to our Sense, or so far forth
 as we can discern by our Sight; and
 consequently all the Rest of the fixed
 Stars (forasmuch as they retain the
 same Situation among themselves) will
 (*) retain the same Situation in re-
 spect of the Celestial *Equator* and *Poles*;
 the Celestial *Equator* being always di-
 rectly over the *Terrestrial*, and the Ce-
 lestial *Poles* being always directly in a
 right Line with the *Poles* of the
 Earth.

(*) Excepting the Change mentioned, Chap. 7.
 Sect. 5.

These

These Difficulties being removed, the CHAP.
 only *Phænomenon* which remains here III.
 to be taken Notice of, is that com-
 monly called *the Eclipse of the Sun*, but 14.
 which ought to be called *the Eclipse* An Eclipse
of the Earth. For the Word *Eclipse* of the Sun,
 does in the *Greek* Tongue signify a *De-* improperly
so called.
ficiency ; and it is used in this Case to
 signify particularly that *Deficiency of*
Light, which seems indeed to us to be
 in the *Sun*, but in reality is such only
 in Respect of the *Earth*. For the *Sun*
 is the Fountain of Light to this our
 Solar System ; and consequently not
 receiving its Light by the Irradiation of
 any other Body upon it, but having its
 Light in it self, cannot suffer any such
 Defect of Light truly and really. Its
 Light may indeed be intercepted or hin-
 dred from coming to us by the Interpo-
 sition of some opacous Body between
 Us and the *Sun*. But then it is the
Earth, on which we are, not the *Sun*,
 that is deficient of Light, or *in an E-*
clipse ; and the opacous Body, whose
 Interposition between the *Sun* and
Earth, causes the *Earth* to be thus in
 an Eclipse, is the *Moon*. Wherefore the
 Explanation of this *Phænomenon* de-
 pending

CHAP. pending on the Motion of the Moon,
 III.] it will be requisite to speak first of that;
 ~~~~~ after which I shall, in a distinct Chap-  
 ter, explain the Eclipses both of the  
 Sun (as it is commonly called) and also  
 of the Moon.



CHAP.



C H A P. IV.

Of the PHÆNOMENA relating to the  
M O O N.

**T**HE Moon is a *secondary* Planet, C H A P. IV.  
forasmuch as she moves round  
the Earth primarily and immediately;   
and round the Sun only in a *secondary* I.  
Manner, *viz.* as she moves round the The Moon  
Earth, which moves round the Sun. a seconda-  
ry Planet.

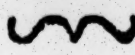
A *Period* or single Revolution of the 2.  
Moon round the Earth from any Point A Periodi-  
cal Month,  
of the *Zodiack* to the same, is called what.  
the Moon's (\*) *Periodical* Month; and  
consists of 27 Days, 7 Hours, and 3  
Quarters.

The Time from one *Synod* or Con- 3.  
junction of the Sun and Moon to ano- A Synodi-  
cal Month,  
ther, is called the Moon's (\*) *Synodi-  
cal* Month, and consists of 29 Days, what.  
12  $\frac{3}{4}$  Hours.

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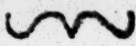
(\*\*) The Words *Period* and *Synod* are both of Greek  
Extraction, the former denoting a going Round a  
Thing, the latter a Meeting together of two or more  
Things.

CHAP. The Reason of the *Synodical* Month  
IV. being so much longer than the *Perio-*

 *dical*, is illustrated *Fig. 8*, where the

4. Circle S denotes the Sun, the Circle  
*The Synodical Month, why longer than the Periodical.* T the *Orbit* of the Earth, T the  
Place of the Earth in the said *Orbit*,  
the Circle M the *Orbit* of the  
Moon; M and *m* two several Places of

the Moon in her *Orbit*, the outer-  
most and greatest Circle of the *Zodiack*.  
Now let the Earth T be supposed in  
the first of *Libra*, and the Moon to be  
in her *Orbit* at M (in a right Line  
between the Earth and the Sun, and  
so) in *Conjunction* with the Sun in  
the first of *Aries*. The Moon moving  
thence Eastward, or according to the  
Series of the Signs, after 27 Days and  
7 Hours and 45 Minutes, appears to  
us again in the first of *Aries*, i. e.  
at the Point M of her own *Orbit*, in  
the second Position of the Earth. For  
in the mean while the Earth has also  
moved almost a whole Sign Eastward,  
*viz.* almost to the End of *Libra*. And  
hence the Moon M, though come a-  
gain to the first of *Aries*, is almost a  
whole Sign Westward of the Sun. This  
is represented by the two prick'd Lines,  
whereof that from M (in the second  
Position

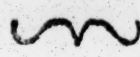
Position of the Earth to  $\gamma$  represents CHAP.  
 how the Moon appears then to us in IV.  
 the first of *Aries*, while the other Line   
 from *m* through *S* to the End almost  
 of  $\gamma$  represents how the Sun appears  
 at the same time to be almost out of  
*Aries*, and so almost a whole Sign East-  
 ward of the Moon. Wherefore the  
 Moon must still move so much further,  
*viz.* from *M* to *m* in her own *Orbit*,  
 before she will be in Conjunction again  
 with the Sun. In going of which to  
 overtake the Sun, is taken up the Time,  
 whereby the *Synodical* Month exceeds  
 the *Periodical*, *viz.* 2 Days, 5 Hours.

It is the *Synodical* Month, which is  
 principally made use of in Computati-  
 on of Time. Forasmuch as the sever-  
 al Parts of this Month are sensibly to  
 be distinguished by the several *Phases* or  
 Appearances of the Moon, respectively  
 belonging thereunto.

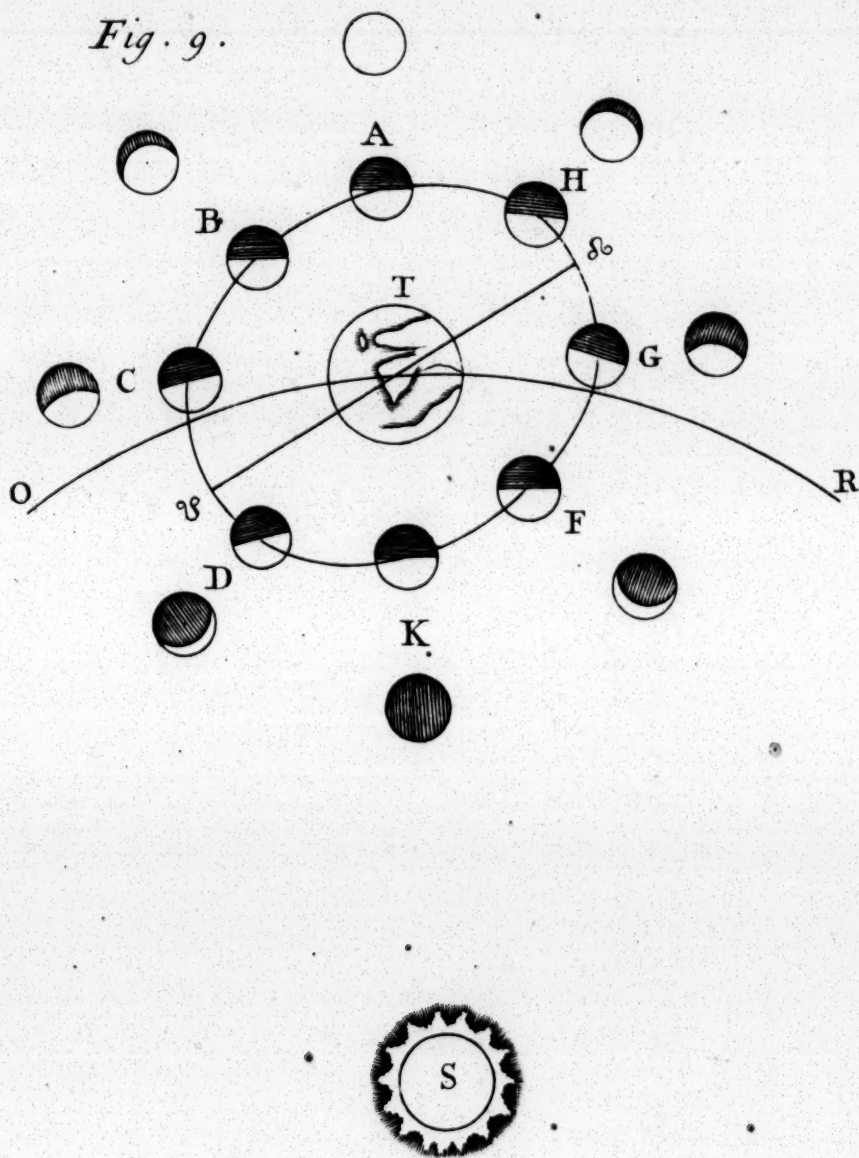
The several *Phases* of the Moon 6.  
 are accounted for thus. The Moon *The sever-*  
 is conceived to be an opacous Body, *al Phases*  
*i. e.* a Body which receives its Light *of the Moon*  
 from the Sun. It is also spherical, *accounted*  
 and consequently has always one Half *for.*  
 of it enlightened, namely, that Hemi-  
E sphere



CHAP. sphere which is towards the Sun. Now

IV.  sometimes more, sometimes less of it, arise the several Phases of the Moon; for the better Understanding whereof it is to be further observed, that although the Moon be a spherical Body, yet the enlightened Portion of it, which is seen by us, appears by Reason of its Distance, as if the Moon had a plain Surface. All which is illustrated, *Fig. 9*, where *S* denotes the Sun, *T* the Earth, *O T R* part of the Earth's Orbit, *A C K G* the Orbit of the Moon, on the several more remarkable Points whereof, *viz.* *A, B, C, D, K, F, G, H*, is represented the Moon with its enlightened and darkened Hemisphere; and at each Point so much of the enlightened Hemisphere, as is within the Circle *A C K G*, is seen by us; but it appears to us, not as it is there represented, (*i. e.* not as a Portion of an Hemisphere,) but as a Portion of some plain circular Surface, as is represented by the several little circular Draughts respectively adjoining. This being premised, 'tis evident from the said Figure the 9th, that the Moon  
being

*Fig. 9.*



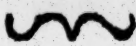




being at A, all its enlightened Hemi- CHAP.  
 sphere is towards the Earth, and seen IV.  
 by Us, whence the Moon appears to us   
 with a full Orb, (i. e. with a plain cir-  
 cular Surface all enlightened,) which  
 Phasis or Appearance is therefore stiled  
 the *Full Moon*. The Moon being mo-  
 ved to B, 'tis evident, that only some  
 Part of its enlightened Hemisphere will  
 be towards the Earth, and so seen by  
 us; whence the Moon will appear like  
 a (\*) plain circular Surface, not fully  
 enlightened, but somewhat defective of  
 Light on that Side which is from the  
 Sun, and consequently will appear gib-  
 bous. The Moon being moved to C,  
 just half of its enlightened Hemisphere  
 will be towards the Earth, and seen by  
 Us: whence the Moon will appear then  
 with an half Orb, or with a semi-  
 circular Surface. The Moon being mo-  
 ved to D, a very little Portion of its  
 enlightened Hemisphere will be seen  
 by Us, and this will appear horned,  
 the Horns bending from the Sun, and

---

(\*) Hence the Face of the Moon is called *Discus*, as  
 resembling a flat round Dish.

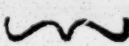
CHAP. so (\*) westward. The Moon being come  
 IV. to K, none of its enlightened Hemis-  
 phere will be towards the Earth, and so  
 the Moon will not be seen by us, and  
 then it is said to be *New Moon*; be-  
 cause the Moon will a little appear *a-*  
*new* in F, and that again horned, the  
 Horns now likewise bending from the  
 Sun, and so (\*) eastward. After which  
 the Moon will appear at G with an half  
 Orb again, (as at C;) and at H gib-  
 bous again, (as at B;) and so will pro-  
 ceed to A, where it will be again Full  
 Moon. And so the Moon will have un-  
 dergone her several Phases; which tho'  
 they somewhat vary every Day, nay,  
 every Hour; yet are usually taken No-  
 tice of, and distinguished only in the  
 fore-mentioned Points.

---

(\*\*) Hence the memorial Verse,

*Dextra cavum Veteris complebit, Lava Recentis, i. e.*  
 when the *Horns* or *Hollow* of the Moon appear *East-*  
*ward*, or on the *left* hand as we look at it, then the  
 Moon is *Increasing*; and this Appearance of the Moon  
 is to be seen only in the *Evening* or *former* Part of the  
 Night, a little *after* its change. But when the *Horns*  
 or *Hollow* of the Moon appear *Westward*, or on the  
*right* hand as we look at it, then the Moon is *Decreasing*,  
 and this Appearance of the Moon is to be seen only in the  
*latter* part of the Night or *towards Morning*, a little *be-*  
*fore* its Change.

Hence

Hence the remarkable Phases of the CHAP. Moon are five; whereof the two prin- IV. cipal are the *New* and the *Full* Moon. 

The three other, viz. the *Gibbous*, 7. *Half*, and *Horned* Moon, occur both The re- markable Phases of the Moon, five. between the New and Full Moon, and also between the Full and New Moon;

only in a different Order. Between the New (which is also called the *Change*) and the Full, the Moon is first horned, then halved, and lastly gibbous; whereas between the Full and Change, she is first Gibbous, then Halved, and lastly Horned.

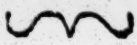
When the Moon is thus Horned, or 8. a little before and after the New Moon, The faint Light which is seen in the whole Discus of the Moon, a little before and after its Change; whence supposed to arise. (*viz.* when the Moon is at the Points D and F,) besides its bright Horns, the Moon has a faint Light, whereby all the Rest of its Discus is rendered discernable. This faint Light has been thought by some to be the Moon's Native proper Light; but is now generally supposed by the learned in Astronomy to be no other than a Reflection of the Sun's Rays upon the Moon, the Earth's Position being such at this Time, as very well suits to such a Reflection, as may be seen, *Fig. 9.* And this Supposition is rendered still



CHAP. more probable, because that as soon as  
 IV. the Moon is moved beyond the Limits  
 of such a Reflection from the Earth, the  
 forementioned faint Light ceases.

9.  
 Of the  
 Moon's A-  
 pogee and  
 Perigee,  
 &c.

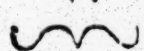
What has been afore observed of the  
 Sun, is also observed by the Curious of  
 the Moon; namely, that in one Part  
 of her *Orbit* she appears lesser, and (*cæ-*  
*teris paribus*) flower, in the opposite  
 Part bigger and swifter. Which *Phæ-*  
*nomena* may be solved after the like  
 manner, as are the like *Phænomena* of  
 the Sun; *viz.* by the Moon's Motion  
 in an elliptical *Orbit*, having one of its  
 Focus's in the Center of the Earth. Ac-  
 cordingly this may be illustrated by *Fig.*  
 7, supposing the Ellipsis AP (which  
 there represents the *Orbit* of the Earth)  
 to represent the *Orbit* of the Moon and  
 the Circle S (which there represents  
 the Sun) to represent the Earth. For  
 then A will represent the Moon's *A-*  
*pogee* or greatest Distance from the  
 Earth, when she will appear lesser; and  
 P her *Perigee* or least Distance, when  
 consequently she will appear greater.  
 And because she is longer in passing the  
 greater Segment of her *Orbit* between  
 her *Apogee* and that Focus of her *Orbit*,  
 which is in the Center of the Earth,  
 than

than the lesser Segment between the said CHAP.  
Focus and her *Perigee*; therefore she IV.  
will appear to move slower, while she   
passes along that Half of the *Zodiack*,  
which answers to the greater Segment  
of her *Orbit*; and swifter, while she  
passes the other Half of the *Zodiack*,  
answering to the lesser Segment of her  
*Orbit*.

Among the *Phænomena* of the Moon  
more obvious to our Sense, there re-  
mains only the Eclipse of the Moon to  
be spoken of, which shall be explained  
in the following Chapter.



## C H A P. V.

*Of the ECLIPSES of the SUN and  
MOON.*C H A P.  
V.

I.

*An Eclipse  
of the Sun  
and Moon,  
what.*

**T**HE Eclipses of the Sun and Moon are here spoken of together, because as they arise from like Causes, so are they to be explained much after the same Manner. For it is to be remembred, that it has been afore (\*) observed, that what is commonly called the Eclipse of the *Sun*, is in reality the Eclipse of the *Earth*. Wherefore, the Earth and Moon being both opacous Bodies, which receive Light from the Sun, an Eclipse of the Earth (commonly called an Eclipse of the Sun) is no other than a Deficiency of Light on the Earth, by the Moon's coming between the Earth and the Sun, so as to hinder the Rays of the Sun from falling on the Earth; just as an Eclipse of the Moon is a

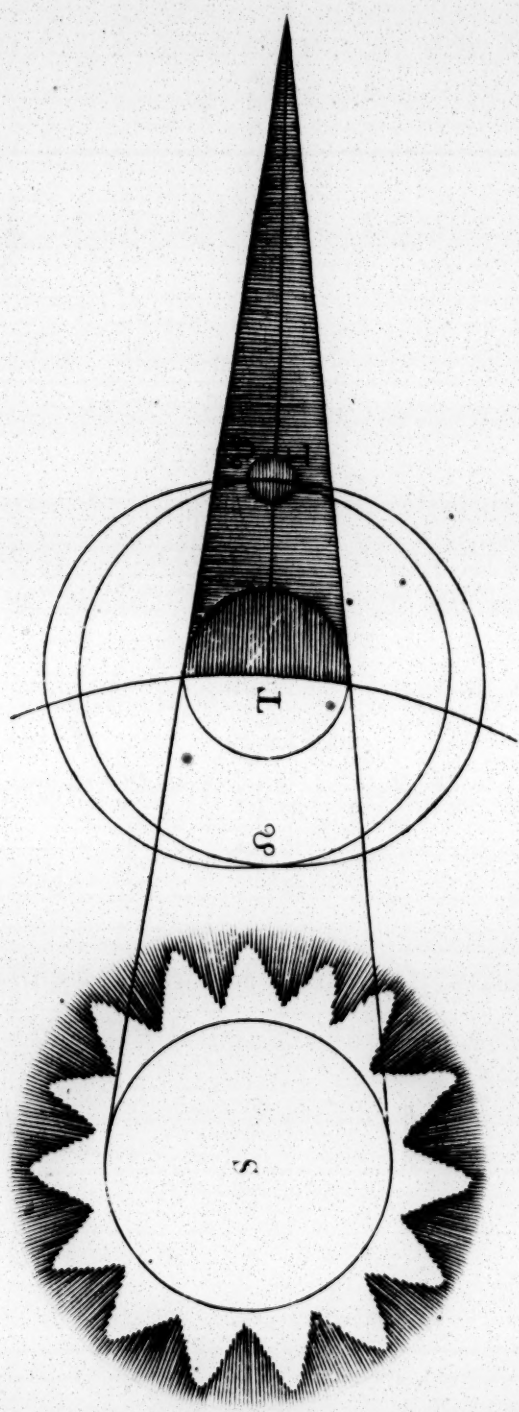
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(\*) Chap. iii. Sect. 14.





*Fig. 10*



Deficiency of Light in the Moon, by CHAP  
the Earth's coming between the Moon V.  
and Sun, so as to hinder the Rays of   
the Sun from falling on the Moon.

Hence it is evident from *Fig. 9*, that 2.  
all Eclipses of the Earth happen at the *Eclipses of*  
Change of the Moon, because then only *the Sun and*  
it is that the Moon comes between the *Moon,*  
Earth and the Sun; and all the Eclipses *when hap-*  
of the Moon happen at the Full of the *pen.*  
Moon, because then only 'tis that the  
Earth can come between the Moon and  
the Sun.

It is to be shewn further, for what 3.  
Reasons there is not an Eclipse of the *Why not at*  
Earth at every Change, but only at *every*  
*some certain* Changes of the Moon; *Change or*  
nor an Eclipse of the Moon at every *Full of the*  
Full, but only at *Moon, but*  
*some certain* Full *only at*  
Moons. It is then to be known, that *some cer-*  
tain Ones.  
the *Orbit* of the Moon crosses the *E-*  
*cliptick*, so as to make an Angle of  
5 Degrees Inclination. The Points  
where the Moon crosses the *Ecliptick*,  
are called the *Nodes of the Moon*, and  
are denoted, *Fig. 10.* by these Charac-  
ters  $\Omega$  and  $\varpi$ ; the former of which  
is called *the Dragon's Head*, the latter  
*the Dragon's Tail*. The Moon crosses  
the *Ecliptick* at the Dragon's Head,  
when



CHAP. when she is entring on that Part of her  
 V. *Orbit*, which inclines northward from  
 ~~~~~ the *Ecliptick*; and she crosses the Dra-  
 gon's Tail, when she is entring on that
 Part of her *Orbit*, which inclines South-
 ward from the *Ecliptick*. Now the
 Nodes being the only two Points,
 where the Moon crosses the *Ecliptick*,
 hence there can be no Eclipse of the
 Earth, but when the Moon happens to
 Change in or near one of the Nodes;
 because in this Case only, the Moon
 at her Change comes so between the
 Earth and the Sun, as to intercept the
 Rays of the Sun, and keep them from
 the Earth. And in like manner, there
 can be no Eclipse of the Moon, but
 when the Moon happens to be at Full,
 in or near one of the Nodes; because
 in this Case only, the Earth comes so
 between the Moon and the Sun, as to
 intercept and hinder the Rays of the Sun
 from falling on the Moon.

4.
 The Sha-
 dow, in E-
 clipses of
 the Sun
 and Moon,
 of what
 Figure.

In an Eclipse of the Earth, the
 Moon by intercepting the Rays of
 the Sun, casts a Shadow on the Earth.
 And in an Eclipse of the Moon, the
 Earth by intercepting the Rays of the
 Sun, casts a Shadow on the Moon.
 These

These Shadows are of a (+) conical CHAP. Figure, growing narrower and narrower V. er, the further they go from the Earth and Moon, till at length they end in a Point, and so cease. Were these Shadows, either of a (*) cylindrical Figure, *i. e.* of an equal Thickness all along; or of a (*) conical Figure, but inverted the other Way, *i. e.* did they grow thicker and thicker, the further they are extended, then they would be extended *in infinitum*. But now 'tis certain, that the Shade of the Earth does not extend to the *Orbit* of the primary Planet *Mars*; forasmuch as when the Earth is directly between the Sun and *Mars*, the latter is not eclipsed, as it must necessarily be, did the Shade of the Earth reach to the *Orbit* of *Mars*.

It being thus demonstrable, that the Shadow of the Earth ends in a Point, before it comes to the *Orbit* of *Mars*; hence it is also demonstrable that the Sun is bigger than the Earth; forasmuch as an opacous Body can't

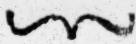
5.
The Sun,
how de-
monstrated
to be big-
ger than
the Earth,
and the
Earth than
the Moon.

(+) As in Fig. 13.

(**) This is evident from Fig. 11 and 12.

cast

CHAP. cast such a conical Shade, but when

V. it is lesser than the lucid Body, whose
 Rays it intercepts. For if the opacous Body be equal to the lucid Body, then the Shadow will be of an equal Thickness all along. And if the opacous Body be greater than the lucid Body, then the Shadow will indeed be of a conical Figure, but in an inverted Manner, that is, so as that the conical Shade will grow wider and wider, as it goes further and further. And as the Sun may be thus demonstrated to be bigger than the Earth, so the Earth may be demonstrated to be bigger than the Moon; forasmuch as the Moon can be totally Eclipsed. For this could not be, was not the Cone of the Earth's Shadow, even in that part of it which the Moon passes through in a total Eclipse, bigger than the Moon, though it be lesser than the Earth itself: what is here said is illustrated, Fig. 11, 12, 13.

6. The Shadows of the Earth and Moon being thus of a conical Figure, it is obvious that an Eclipse either of the Earth or of the Moon will be (*cæteris paribus*) greater or longer,

The Greatness of an Eclipse depends in one Respect on the

Fig. 14.

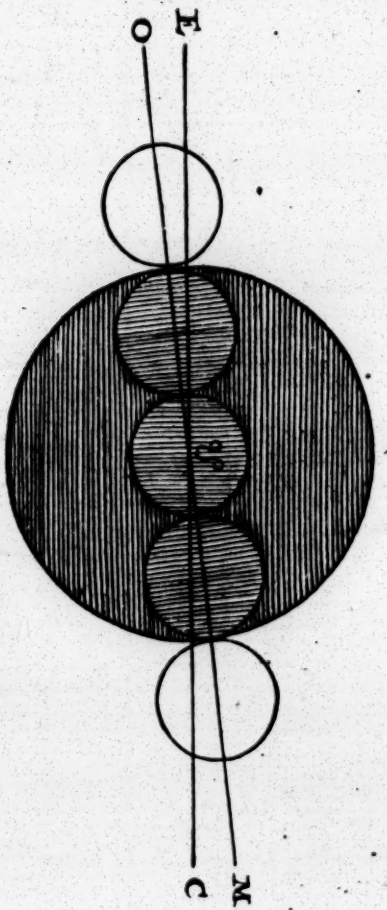


Fig. 15.

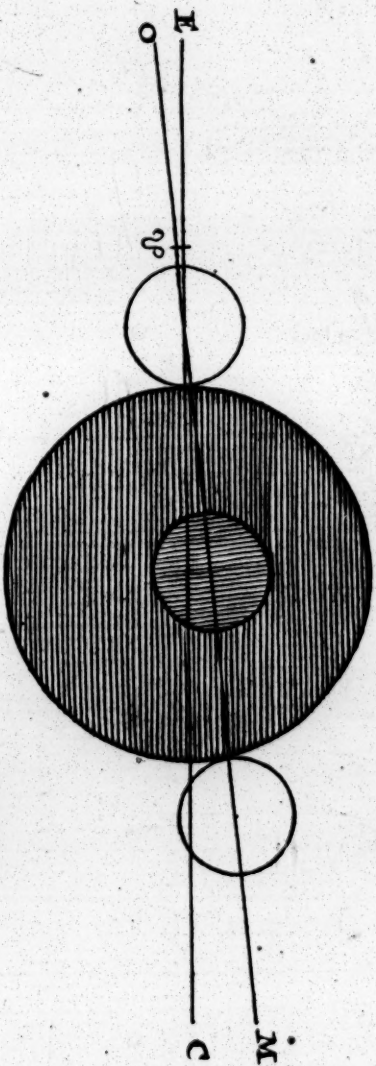
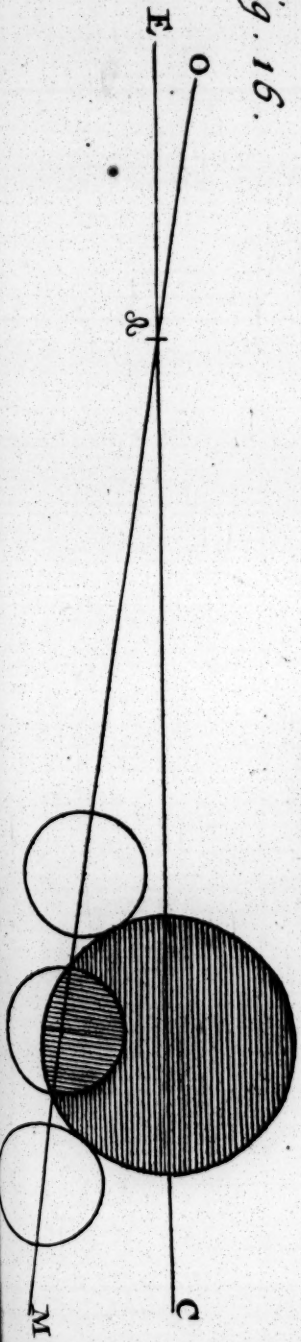


Fig. 16.



Place this facing Page 60.

Astronomy Plate 9.

Fig. 11.

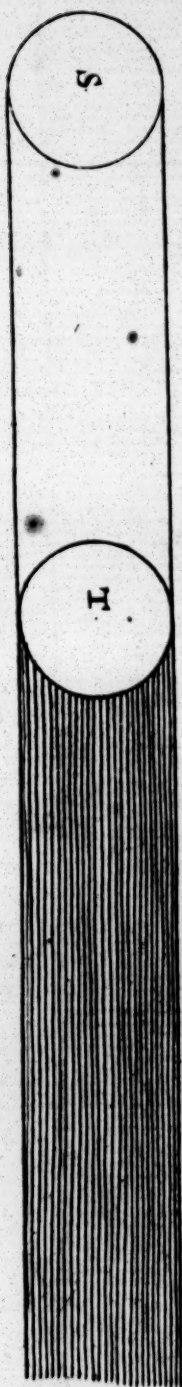


Fig. 12.

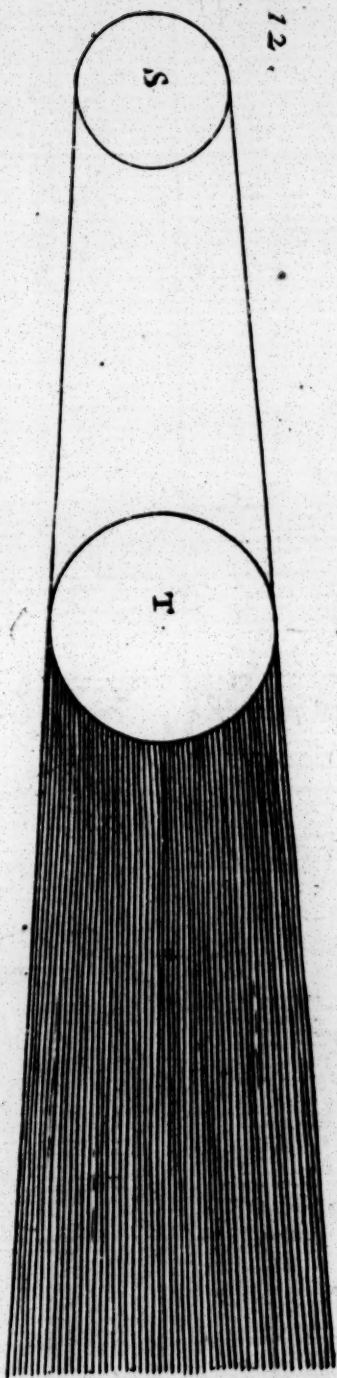
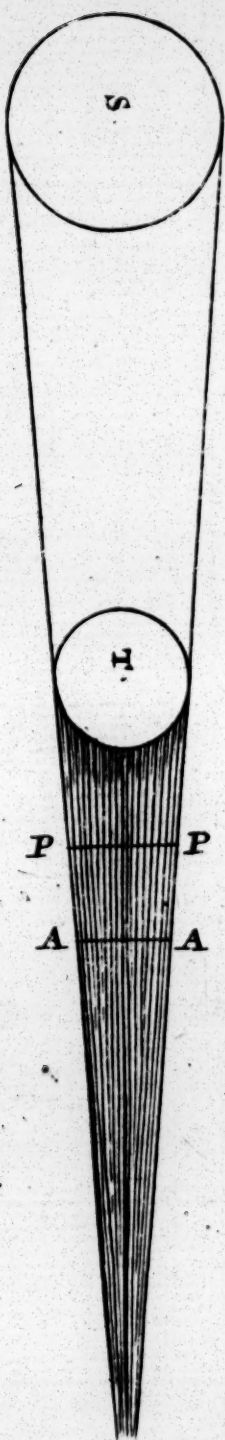
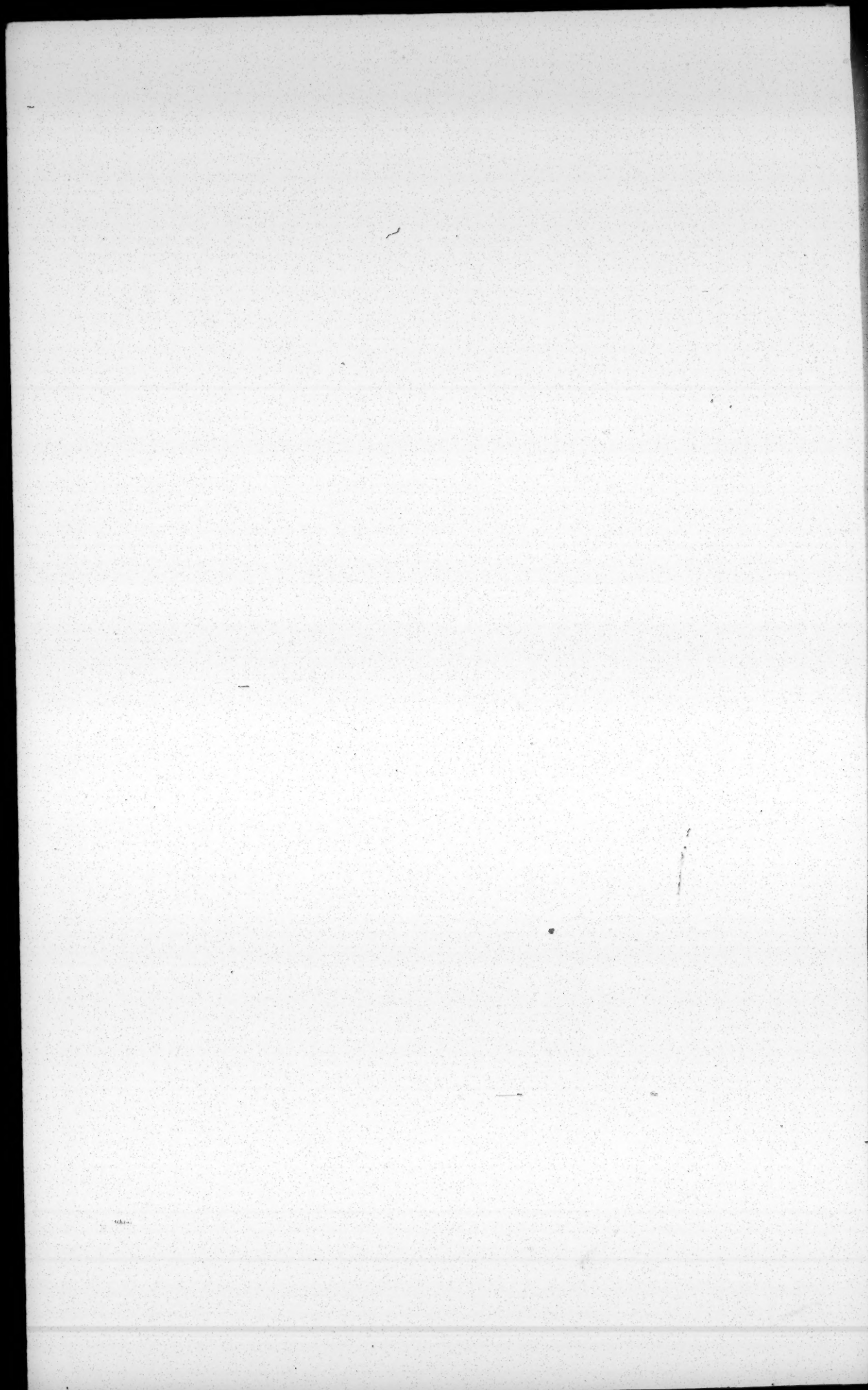
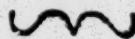


Fig. 13.





longer, when the Moon is in her *Perigee*, than when she is in her *Apo-gee*. For the Moon if she be eclipsed in her *Perigee*, meets with a thicker Part of the Line of the Earth's Shadow, than if she be Eclipsed in her *Apogee*; as is obvious from *Fig. 13*, where the Line PP denotes the Moon's Passage through the Shadow in her *Perigee*, and the Line AA in her *Apo-gee*. And in like manner, if the Earth be eclipsed when the Moon is in her *Perigee*, it meets with a thicker Part of the Cone of the Moon's Shade, than it does if it be eclipsed when the Moon is in her *Apogee*; as is obvious also from *Fig. 13*, taking the Circle T to denote the Body of the Moon; and the Line PP to denote the Passage of the Earth through the Shade of the Moon in her *Perigee*, and AA to denote the like in the *Apo-gee* of the Moon.

CHAP. V.

Moon's being in her Apo-gee or Perigee.

But the Variety, that is observed in Respect to the Greatness and Duration of Eclipses, does principally arise from the Moon's being then more or less distant from a Node or the *Ecliptick*. Which shall be illustrated,

7.
But principally on the Moon's Distance from her Nodes.

CHAP. trated, first in reference to the Moon,
V. then in reference to the Earth.

~~~~~ An Eclipse of the Moon, considered as to its *Greatness*, is either *Total*, when the whole Moon is eclipsed; or *Partial*, when only a Part of it is eclipsed.

An Eclipse  
of the  
Moon, Total or Partial.

9.  
A Central  
Eclipse of  
the Moon,  
what.

As to *Duration*, every total Eclipse holds longer than any partial One. And, as some partial Eclipses are of longer Duration than other Partial, so some total Eclipses are of longer Duration than other Total. Such total Eclipses, as are of the longest Duration, happen when the Moon is in a Node, and are called *central* Eclipses, because, as the Moon passes through that Section of the Cone of the Earth's Shadow, which meets with the *Orbit* of the Moon, the Center of the Moon passes exactly through the Center of the said Section or Shadow.

10.  
A Central  
Eclipse illustrated.

This is illustrated, *Fig. 14*, where the shaded Circle represents the Section afore-mentioned of the Earth's Shadow; O M the *Orbit* of the Moon, EC the *Ecliptick*. 'Tis evident, that the Moon in this Case crossing a Diameter of the shaded Circle, makes the longest



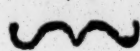
longest Stay she can make in the Shadow of the Earth; and this Stay is computed about four Hours long. CHAP. V.

Whereof the Moon takes up one Hour from her Beginning to enter into the Shadow, till she is quite immerged therein; two Hours more she continues quite immerged, passing on through the Shadow; and the fourth Hour is taken up from her first Beginning to come out of the Shadow, till she is got quite free of it. Whence by the Way it appears, that the Wideness of the Shade is equal to about three Diameters of the Moon.

In Fig. 15, is represented a *total*, but *not-central* Eclipse; which happens when the Moon meets with the Shadow of the Earth, though not at a Node, yet at a small Distance from it. And as it is obvious from the same Figure, that every total, but not-central Eclipse must be of a shorter Duration than a central, so it is also obvious that one total, but not-central Eclipse will be longer than another, in Proportion to the Moon's greater or less Distance from a Node at that Time.

In

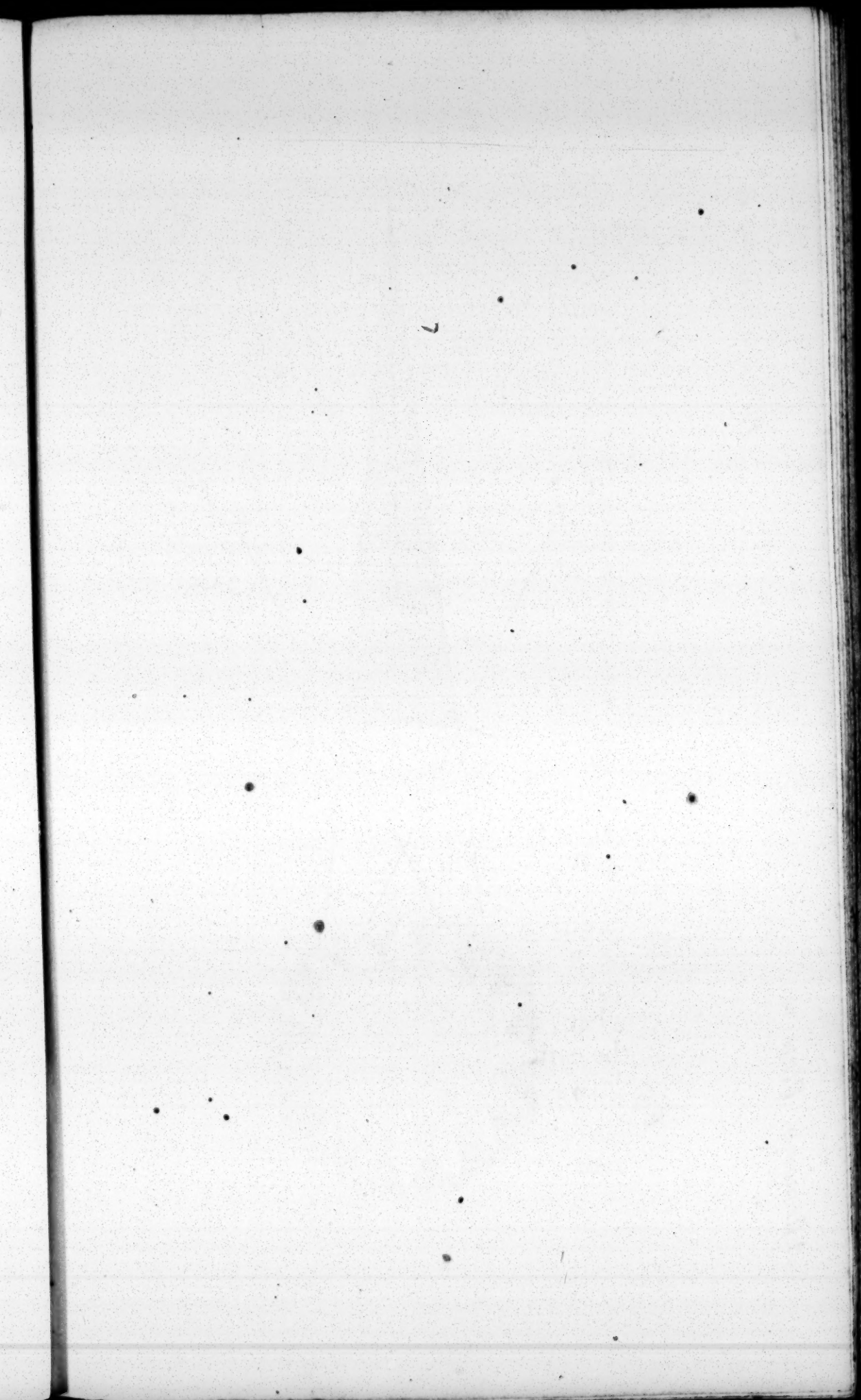
CHAP. In *Fig. 16.* is represented a partial V. Eclipse. And it is evident from the



12. must be of longer Continuance than any partial; so one partial Eclipse is of longer Continuance than another, according as the Moon is then more or less distant from a Node. It is also obvious, that the longer a partial Eclipse is, so much greater is it, *i. e.* so much greater Part of the Moon is darkned or passes through the Shadow of the Earth. Hence it is usual to conceive the Moon's Diameter, as divided into twelve Parts, called *Digits*; by which the Greatness of partial Eclipses are measured and distinguished; they being said to be of so many Digits, as there are such twelve Parts covered by the Shadow of the Earth, when the Eclipse is at greatest.

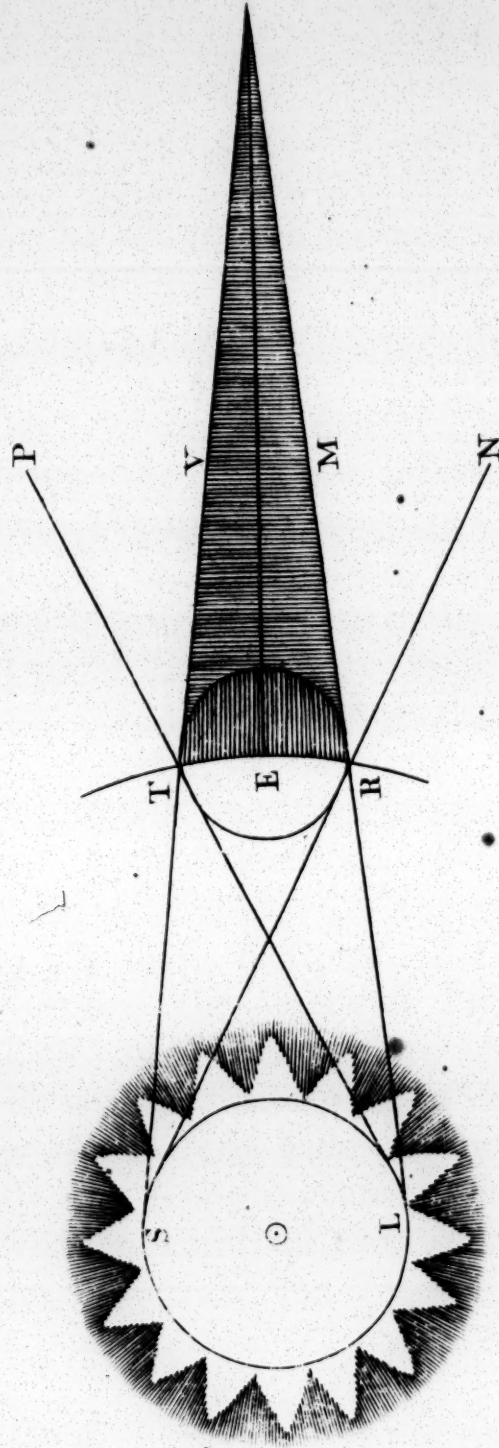
13. In all these Eclipses of the Moon, she enters the western Side of the Shadow with her eastern Side; and so it is her western Side which last quits the eastern Side of the Shadow, when the Eclipse ceases. But now as the eastern Limb or Side of the Moon draws towards the Shadow; before it

*Of the Pen-  
umbra in  
Eclipses of  
the Moon.*





*Fig. 17.*



it enters the thick Shadow it self, and CHAP. V  
is quite darkened, it grows more and more dim, as it comes nearer and nearer to the Shadow. Which Dimness arises from a Penumbra or Duskyhness, which always attends such Shadows, and encompasses them all round. Thus *Fig. 17*, T U M R represents the Shadow, (where comes not any Part of the Sun's Light,) which is encompassed all round with the Penumbra U T P M R N, where only some Part of the Sun's Light is intercepted by the Earth. And this Penumbra is more dim towards T U and M R the edges of the perfect Shadow, because the Rays of a lesser Portion of the Sun, and so fewer Rays reach thither; and less dim towards T P and R N, where more Rays fall; and beyond which Limit, all the Rays of the Sun have a free Course.

In some Eclipses the Moon quite disappears in the perfect Shadow. At other Times she appears even in the Midst of the perfect Shadow, of a reddish Colour like a burnt Brick. Which reddish Colour is supposed to arise from the Rays of the Sun, ei-  
F ther

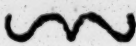
14.

*The Moon why appears of a reddish Colour in total Eclipses.*

CHAP. ther refracted in the Atmosphere about  
 V. the Earth, or reflected to the Moon  
 ~~~~~ by Particles flying without the Shadow  
 of the Earth; or else to arise from the
 Illumination of the Stars, or all these
 Causes together.

15. There happen most Years two E-
 clipses of the Moon at least. For
 there being two Nodes, wherein the
 Moon crosses the *Ecliptick*, and which
 move contrary to the Series of the
 Signs, and the Earth going round the
Ecliptick every Year the other Way,
 or according to the Series of the
 Signs; hence it is obvious that the
 Earth must meet the Moon's Nodes
 every Year. If therefore it happens
 then to be Full Moon, there must be
 a central Eclipse. If it be not then
 Full Moon, but more than ten Days
 (and more than fifteen it cannot be)
 either before or after a Full Moon;
 yet so great is the Inclination of the
 Moon's *Orbit* to the *Ecliptick*, and so
 great is the Thickness of the Cone of
 the Earth's Shadow, that the Moon
 will scarce miss going through some
 Part of the Shadow; and consequent-
 ly there will be at least a partial E-
 clipse. But if the Earth happens to
 meet

How ma-
 ny Eclipses
 of the Moon
 usually
 happen
 in a Year.

meet a Node of the Moon on the very CHAP.
Day of a New Moon, or one or two V.
Days before or after, (which happens ) in this Case the Moon
but seldom) in this Case the Moon
will be far enough to avoid the Sha-
dow of the Earth, both in the fore-
going, and also following Full Moon;
and so there will be no Eclipse of the
Moon that half Year. And this may
suffice in Relation to the Eclipses of the
Moon.

Proceed we now to the Eclipses of 16.
the Earth, which are commonly cal- *An Eclipse*
led Eclipses of the Sun, forasmuch as *of the Sun*
the Moon, which more or less covers *Total or*
the Sun, being not seen by us, the *Partial.*
Deficiency of Light appears to our
Sight as in the Sun it self. Whence
an Eclipse of the Sun is distinguished
also into a *total* Eclipse, wherein the
Moon covers the whole Body of the
Sun from us; and a *partial* Eclipse,
wherein the Moon covers only a Part
of the Sun.

But it is to be well observed, that 17.
although an Eclipse of the Sun be in *Of a Total*
reality an Eclipse of the Earth; yet *Eclipse of*
what is called a *total Eclipse of the* *the Sun.*
Sun, is not to be conceived as in rea-
lity a *total Eclipse of the Earth*; or
F 2 that

CHAP. that the whole upper and opposite

V. Hemisphere of the Earth is then deprived of the Sun's Light, as in a Total Eclipse of the Moon is the whole opposite Hemisphere of the Moon. The Reason of which Difference is this. The Earth being bigger than the Moon, the Cone of its Shadow is big enough to involve the whole opposite Hemisphere of the Moon in its Darknes. Whereas the Moon being less than the Earth, the Cone of her Shadow will involve at once only a small Tract (CD in *Fig. 18*.) of the opposite Hemisphere of the Earth, so as to hide the whole Sun from the Inhabitants thereof; and consequently there will appear only to these a Total Eclipse of the Sun, whilst to the Inhabitants of the adjoining Tracts B C, and D E, the Sun will appear to be but partially Eclipsed; and beyond these on each Side, there will be no Eclipse at all of the Sun, as is evident from the same *Fig. 18*.

18. The Moon moving from West to East, that is, from $\sphericalangle$ through m to r , hence her eastern Limb appears to us first to cover the western Limb of the Sun. And when there is a
The Sun continues to be eclipsed, but a very short while.

Total

Fig. 18.

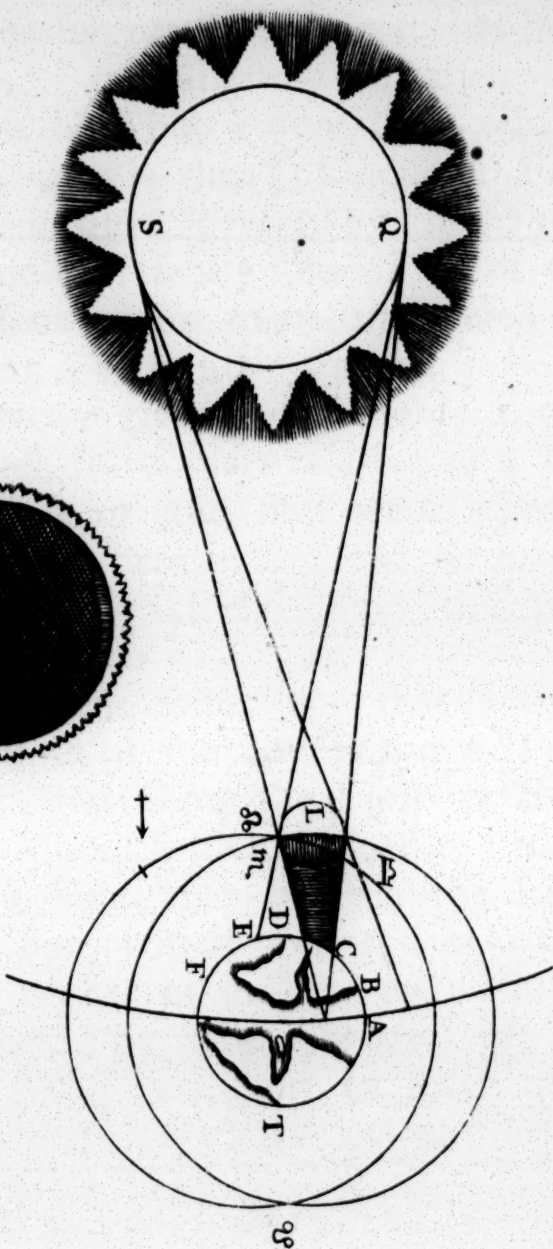
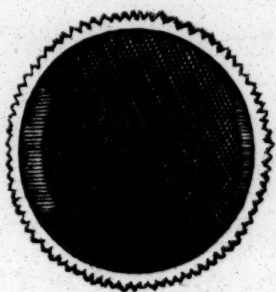
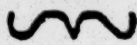


Fig. 19.



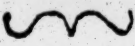


Total Eclipse of the Sun, for the Time CHAP.
that the Moon covers all the Sun from V.

us, it is so dark, as that sometimes the  Stars have appeared, and there has been need of Candle-light. But then this Darkness lasts but a very little while; for no sooner is the (*) Discus or Face of the Sun quite covered by the Moon, but almost presently some Part of the said Discus begins to be uncovered again, and a very little Part of it being so uncovered gives a considerable Light. All which Particulars relating to a Total Eclipse of the Sun were actually exemplify'd here in *England* no longer than *April 1715*, and again, this present Year, *May 11. 1724*.

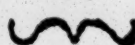
It happens sometimes, that a Cen- 19.
tral Eclipse of the Sun is not a Total A central
Eclipse of
the Sun
may be not
a Total. Eclipse; but about the Limb or Edge of the Moon, which looks like a black or dark Spot, may be seen the Limb of the Sun, which appears like a Circle of Light, as in *Fig. 19*. This is occasioned by the Shadow of the Moon being too short to reach quite

(*) The Sun's Face is called its *Discus*, for the like Reason, as the Moon's Face is so called, taken Notice of *Chap. 4. Sect. 6*.

CHAP. to the Earth; and this Shortness of the
 V. Moon's Shadow may be occasioned,
 either by the Moon being in her *Apo-*
gee, or else by the Rays of the Sun,
 which pass by the Edge of the Moon,
 being bent by Inflection, and so short-
 ening the Shade of the Moon.

20. The greatest Eclipse of the Sun
 (wherein the Shadow of the Moon
 passes along the middle of the Earth)
 is, when the Moon happens to be in
 a Node at the moment of her Change.
 If she be not far from a Node, the
 Shadow of the Moon, or at least some
 Part of the Penumbra will fall on some
 Tract of the Earth, (as being large e-
 nough,) and will there make a Total,
 or at least partial Eclipse. And in this
 Respect there are more Eclipses of the
 Sun, than of the Moon. But in Re-
 spect of any one given Place of the
 Earth, there are much fewer visible E-
 clipses of the Sun than of the Moon,
 for the Shade of the Moon is lesser than
 the Shade of the Earth; and conse-
 quently the former will not so often in-
 volve any given Place of the Earth, as
 the latter will some Part of the Moon.

It

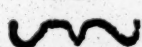
It remains now only to observe, that CHAP.
the *Ecliptick* is so called, because all the V.
fore-mentioned Eclipses happen, only 
when the Moon is in or near a Node, 21.
i. e. in or near the Plane of the *Eclip-* The Eclip-
tick. And as all Eclipses of the Sun tick, why
and Moon happen in the *Ecliptick*, so so called.
likewise do the Eclipses of the other
Planets, of which we come now to
speak.



C H A P. VI.

Of the PHÆNOMENA of the primary Planets, of SATURN, JUTITER, MARS, VENUS, and MERCURY; as also of the secondary Planets, or the SATELLITES of SATURN and JUPITER.

CHAP.
VI.

 AS there are five primary Planets besides the Earth, so they are distinguished, by Reason of their Situation

I. with Respect to the Earth, into *Inferiour* and *Superiour*. The former are such as move between the Earth and Sun, and are two, *Venus* and *Mercury*; the latter are such, as have the *Orbit* of the Earth between the Sun and their own *Orbits*, and these are three, *Saturn*, *Jupiter*, and *Mars*. This with their respective Order may be seen, *Fig. 1.*

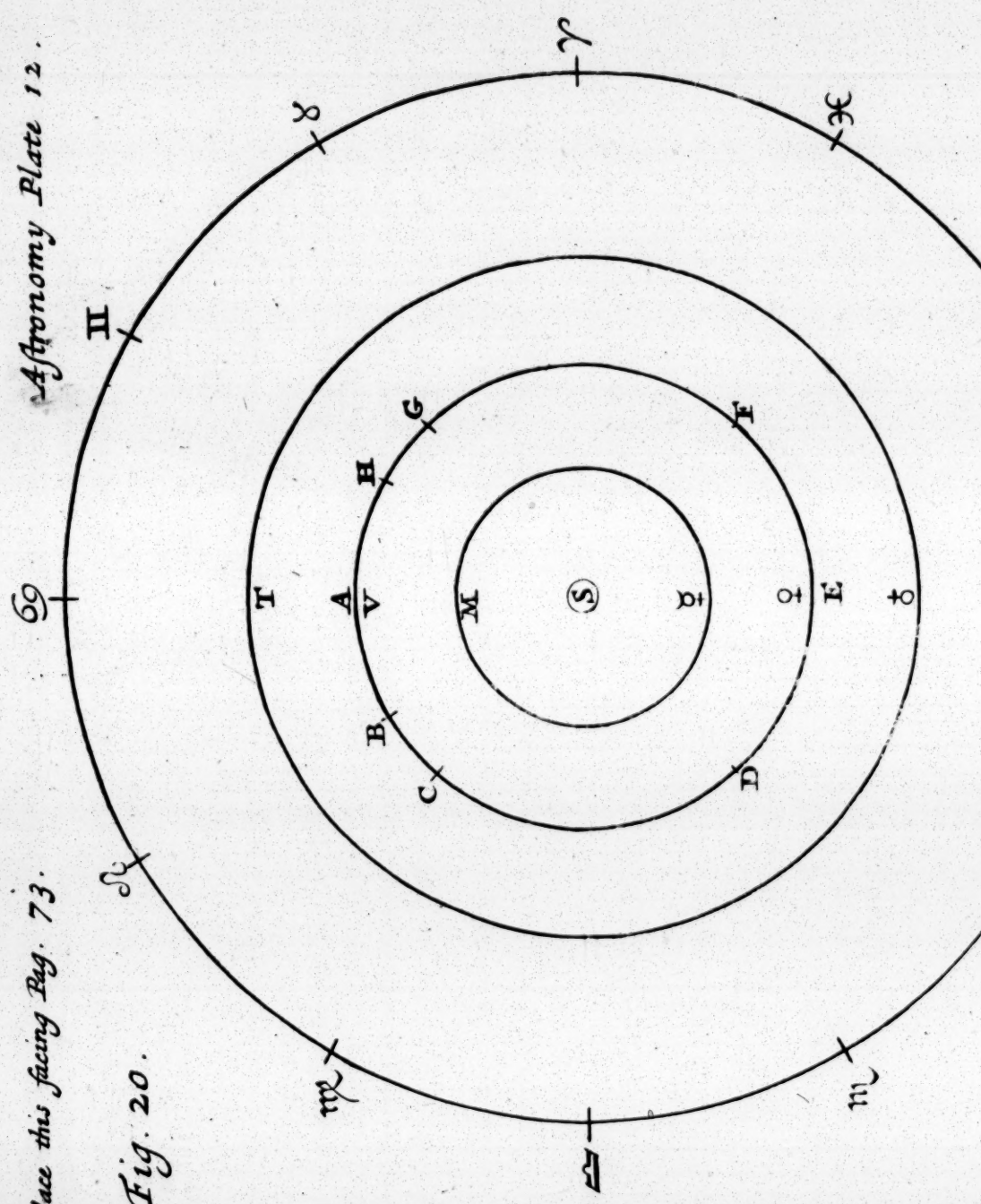
2. Although both inferiour and superiour Planets agree in this, that the Planes of their *Orbits* cross the Plane of the *Ecliptick*; yet their different Situation

The primary Planets distinguished into Superiour and Inferiour, with Respect to the Earth.

Hence arises some Difference,

Place this facing Pag. 73.

Fig. 20.



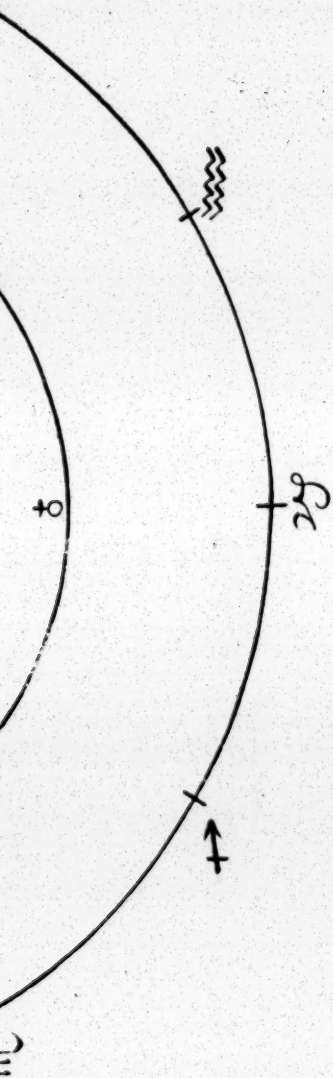


Fig. 21.

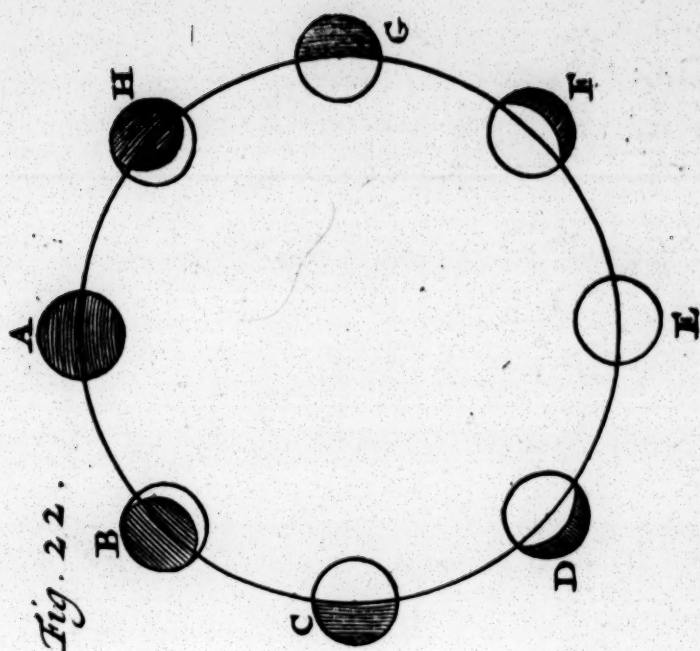
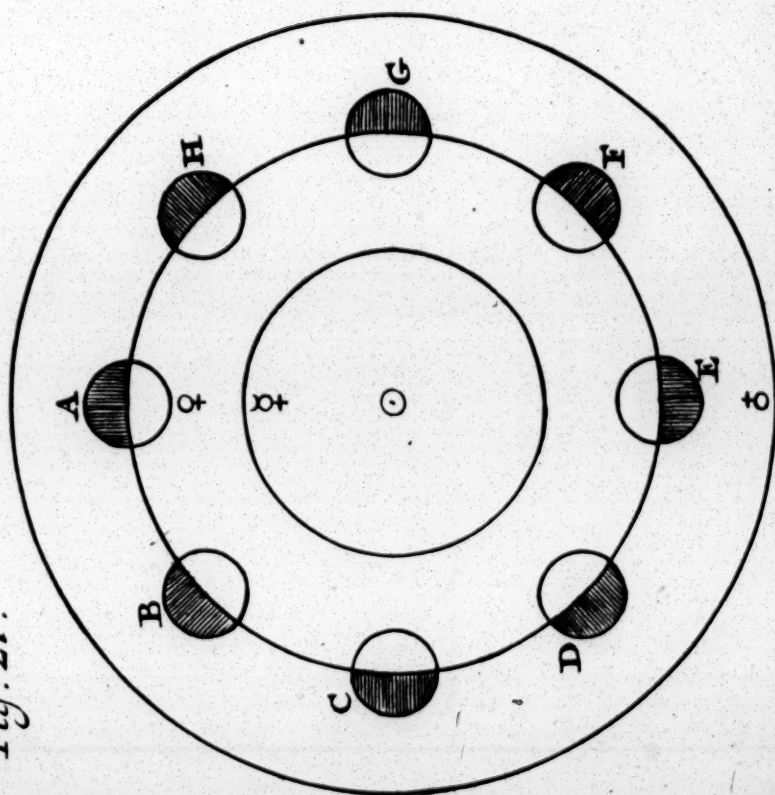
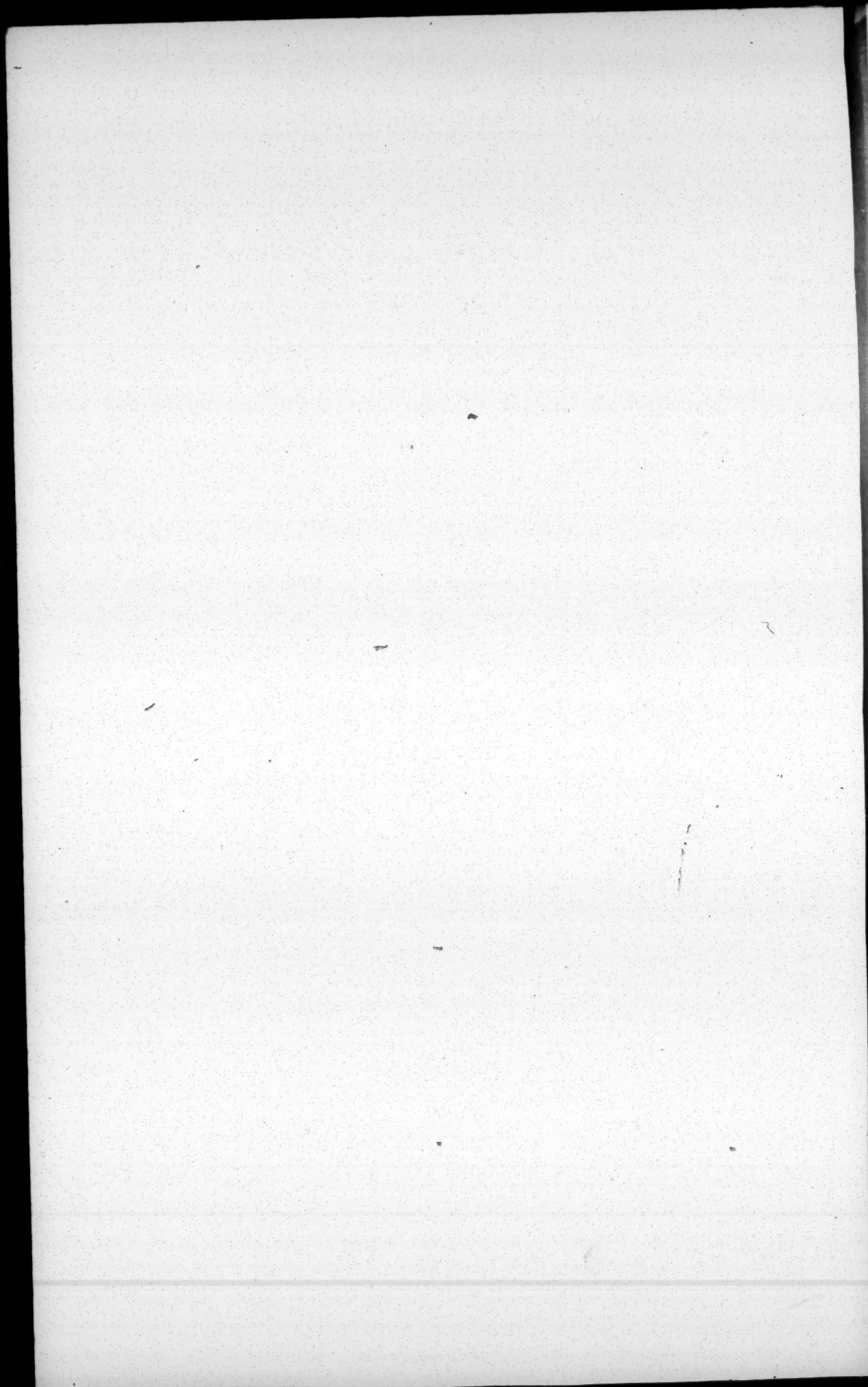
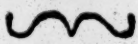
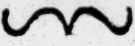


Fig. 22.



Situation with Respect to the Earth CHAP.
occasions some Difference in the Phæ- VI.
nomena respectively belonging to them. 

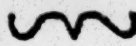
I shall begin with the inferiour Pla- as to their
Phæno-
mena.
nets, whose *Orbits* together with the
Orbit of the Earth and *Ecliptick* are 3.
represented, *Fig. 20*, namely, M ♀ re- The inferi-
our Planet
Venus,
Venus, T the Earth in it *Orbit* T ♂, why it ap-
pears some-
times to
move Di-
rectly,
sometimes
Backward,
and some-
times to
stand still.
the outermost Circle represents the *E-
cliptick*; the little Circle with S in the
Center represents the Sun. Now *Ve-
nus* moving in a lesser *Orbit* than the
Earth, but the same Way, *viz.* from
West to East; it is evident, that when
Venus is in DEF the more remote Part
of her *Orbit* from the Earth T, she will
appear to us in T to move according
to the Series of the Signs, (*viz.* from
♄ to ♀, &c.) and so to move di-
rectly forward. When *Venus* is come
to G, from thence to H, she will still
appear to move directly forward, but
slower than before; forasmuch as she
now moves as it were in a straight
Line towards T the Earth. As she
passes beyond H through A to B,
moving quicker than the Earth, she
will pass between the Earth and the
Sun,

CHAP. Sun, and will seem to us on the
 VI. Earth to move contrary to the Series of
 the Signs, (*viz.* from ♄ to ♃,) and so
 to have a *retrograde* Motion, or to move
 backward. Between her direct and re-
 trograde Motion, *viz.* about H, she will
 appear *stationary*, i. e. to stand still;
 forasmuch as the right Lines then
 joining the Earth, and *Venus* will for
 some Time continue parallel. And in
 like manner between her retrograde
 and direct Motion, *viz.* about B, she
 will appear a second Time to stand
 still. From what has been said 'tis
 obvious, that *Venus*, when she is re-
 trograde, as at A, is nearer the Earth,
 and therefore seems bigger; and on
 the other hand when she is direct, as
 at E, she is more remote from the
 Earth, and so (*cæteris paribus*) seems
 lesser.

4.
 The several Phases
 of Venus.

The several Phases of *Venus*, ac-
 cording to her different Position with
 Respect to the Earth, are represented
 as they are in themselves, *Fig. 21.*
 Whence it is evident, that when *Ve-*
nus is at A, that is, most retrograde
 and nearest to the Earth, she does
 not appear to us, her dark Face be-
 ing

ing towards us, and if she then hap- CHAP. VI.
pens to be in or near enough to a Node, VI.

she will pass directly between the Earth  and Sun, and so seem as a spot in the Sun. Otherwise, if she be far enough from a Node, she will go on one side of the Sun, either Northward or Southward. At B she will appear horned, at C with an half Orb, at D gibbous, and at E (where she moves most directly, and is most remote from the Earth) with a full Orb; unless she be then in or near enough to a Node, in which Cases she will be hid from us by the Sun. After her Full, *Venus* undergoes the same Phases as afore, only in an inverted Order, till she comes to her Change again. As *Fig. 21*, represents the several Phases of *Venus*, as they are in themselves; so *Fig. 22*, represents them, as they appear to us on the Earth; the correspondent Phases being denoted in both Figures by the same Letters, A, B, C, &c.

Lastly, *Venus* moving round the 6.
Sun at a lesser Distance than the Earth Why Venus appears always accompanying the Sun; and does, hence to us she appears as always accompanying the Sun; her greatest Elongation or Distance from the

CHAP. the Sun being about 45 Degrees, or a
 VI. Sign and Half. When she appears
 before the Sun in the Morning, and so
 does as it were usher in Day-light, she
 is then called *Phosphorus* or *Lucifer*,
 or the *Morning Star*; when after the
 Sun at Evening, then she is called
Hesperus or *Vesper*, or the *Evening*
Star.

why called
 Phospho-
 rus, and
 Hesperus,
 &c.

6. What has been said and illustrated
 concerning *Venus*, is also to be under-
 stood in reference to the like *Phænome-
 na* of *Mercury*; only it must be confi-
 dered, that the *Orbit* of *Mercury* being
 lesser than that of *Venus*, hence *Mer-
 cury* never appears at such a Distance
 from the Sun, being never a whole Sign
 distant from it, and so very seldom to
 be seen. In like manner, *Mercury* go-
 ing round its *Orbit* in shorter Time
 than *Venus* does her *Orbit*; hence the
 direct Motions, Stations, and Retrogra-
 dations of *Mercury* will occur oftner,
 than those of *Venus*. And so much may
 suffice for the two inferiour primary
 Planets.

Of the
 Phæno-
 mena of
 Mercury.

7. As the Agreement between the
Phænomena of *Venus* and *Mercury* a-
 rises from their being both inferiour
 Planets

The A-
 greement
 between



Planets to the Earth; so a like Agree-ment between the *Phænomena* of *Mars*, *Jupiter*, and *Saturn*, arises from their being superiour Planets to the Earth.

Let then in *Fig. 23*, T δ represent the *Orbit* of the Earth, M δ the *Orbit* of (any superiour Planet, particularly) *Mars*. 'Tis evident, that *Mars* will not appear to us always accompanying the Sun, (as do the inferiour Planets, *Venus* and *Mercury*,) but will appear sometimes as *diametrically opposite* to the Sun. For whereas the Earth goes round its *Orbit* sooner, than *Mars* does his; 'tis obvious that the Earth will sometimes be in the middle between *Mars* and the Sun; for Instance, while *Mars* is at M, the Earth may be at A.

Further, supposing *Mars* to be in M, and the Earth to be in B, *Mars* will appear stationary, for the Reason assigned, *Seet. 3*, concerning the like *Phænomena* of *Venus*. As the Earth moves from B through C, D, E, F, G to H, *Mars* will appear to move forward among the fixed Stars; but with this Difference, that he will appear

the Phænomena of the superiour Planets, arises from such their Situation.

8. The superiour Planet Mars appears sometimes Diametrically opposite to the Sun.

9. The superiour Planet Mars, why appears sometimes to stand still, sometimes to move forward, sometimes backward.

CHAP. appear to move quicker, when he is
 VI. most remote from the Earth, and in
 ~~~~~ Conjunction with the Sun, (*i. e.* when  
 he and the Earth are so situated, as is  
 represented, *Fig. 23*, by supposing the  
 Earth to be in DEF, and *Mars* in or  
 about M,) and slower, when he is so  
 situated with respect to the Earth, as  
 M is represented, *Fig. 23*, to be situa-  
 ted with respect to either of the two  
 Segments of the Earth's *Orbit*, BC or  
 GH. Whenever the Earth has such  
 a Situation to *Mars*, as H hath to M  
 in *Fig. 23*, ( which will at length be,  
 forasmuch, as although *Mars* moves the  
 mean Time round the Sun, the same  
 Way as the Earth, or according to the  
 Series of the Signs; yet the Earth  
 moves faster, and so will overtake  
*Mars*,) the Planet *Mars* will again ap-  
 pear to stand still. And some short  
 Time after will appear to go backward,  
 or contrary to the Series of the Signs.  
 For the Earth, as it moves from H  
 through A to B, having overtook and  
 gone beyond *Mars*, will make *Mars* ap-  
 pear to us to move contrary to the Se-  
 ries of the Signs, or from ♄ towards ♀,  
 &c. And in this Situation *Mars* ap-  
 pears

appears opposite to the Sun, and also CHAP. VI.  
greatest, because it is then nearest to the Earth.

The like *Phænomena* happen to *Jupiter* and *Saturn*, save that the Retrogradations of *Saturn* are more frequent than those of *Jupiter*, and of *Jupiter* than those of *Mars*; forasmuch as the Earth does oftner overtake *Saturn* than *Jupiter*, and *Jupiter* than *Mars*.

10.  
Jupiter  
and Saturn  
have the  
like fore-  
mentioned  
Phæno-  
mena with  
Mars.

'Tis obvious, that the *Orbit* of the Earth being nearer the Sun than the *Orbits* of the Superiour Planets, none of these can hide the Sun from the Earth. But on the contrary, any of them may be hid by the Sun, while the said Planet is direct, if it be but near enough to a Node.

11.  
None of  
the superi-  
our Planets  
can hide  
the Sun,  
but any of  
them may  
be hid by  
the Sun.

*Lastly.* *Saturn* and *Jupiter* appear not to us with several Phases, but always with a full Orb; forasmuch as that Hemisphere of each, which is toward the Sun, and so enlightened, is also always toward the Earth, the Earth being (comparatively) never far distant from the Sun, which is the Center of the *Orbits* of *Jupiter* and *Saturn*, For the Distance of *Jupiter* from the Sun is above five Times, and

12.  
Saturn and  
Jupiter,  
why appear  
always  
with a full  
Orb.



CHAP. and that of *Saturn* almost ten Times  
VI. greater than that of the Earth from the  
~~~~~ Sun.

13. But it is not so as to *Mars*. For
Mars, *why* the Distance of *Mars* from the Sun
not ap- being but (*) half as much again as
pear so the Distance of the Earth from the
likewise. Sun, it follows that the Hemisphere
of *Mars*, which is towards the Sun,
will not always (so much as sensibly
appear to) be toward the Earth. In
Fig. 24. let T be the Place of the
Earth in its *Orbit* T δ , and the Circle
A B C D denote the *Orbit* of *Mars*,
'Tis evident, that *Mars* being in A or
B, (that is, either in Conjunction
with, or in Opposition to the Sun,) turns the same Face towards the
Earth, as it does towards the Sun,
and so shines with a Full Orb. But
in C or D the enlightened Face or
Hemisphere of *Mars* is not at all seen;
but *Mars* appears a little defective of
Light, in that Part of it which is
from the Sun, and so appears gib-
bous. And thus we have solved at
least the more remarkable *Phænomena*,

(*) That is, as 15. to 10.

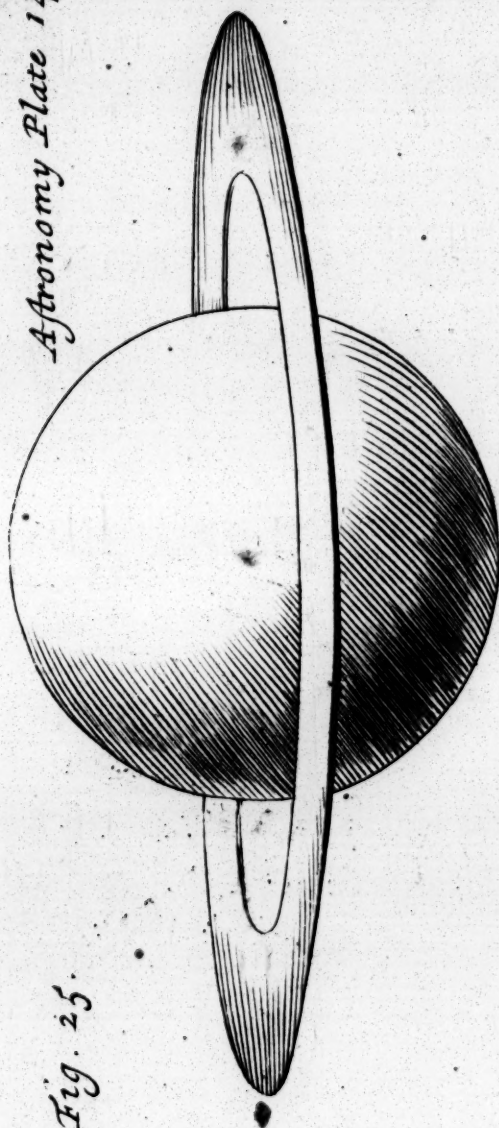


Fig. 25.



Fig. 26.

Fig. 26.

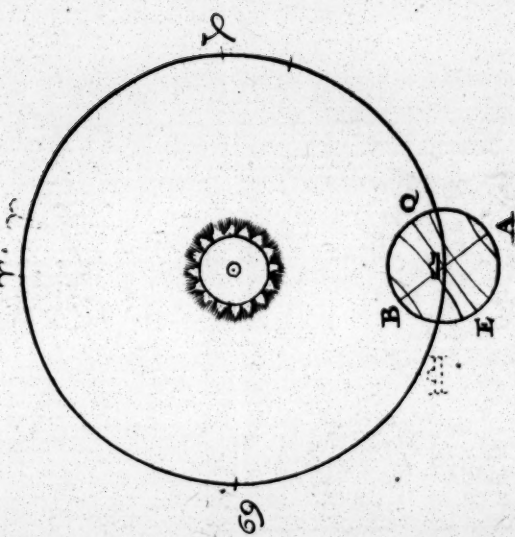
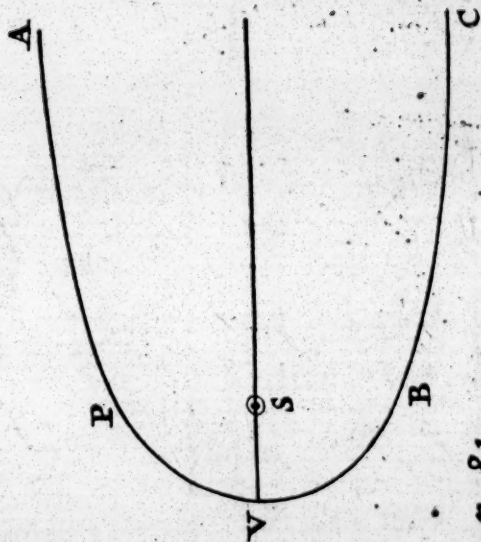
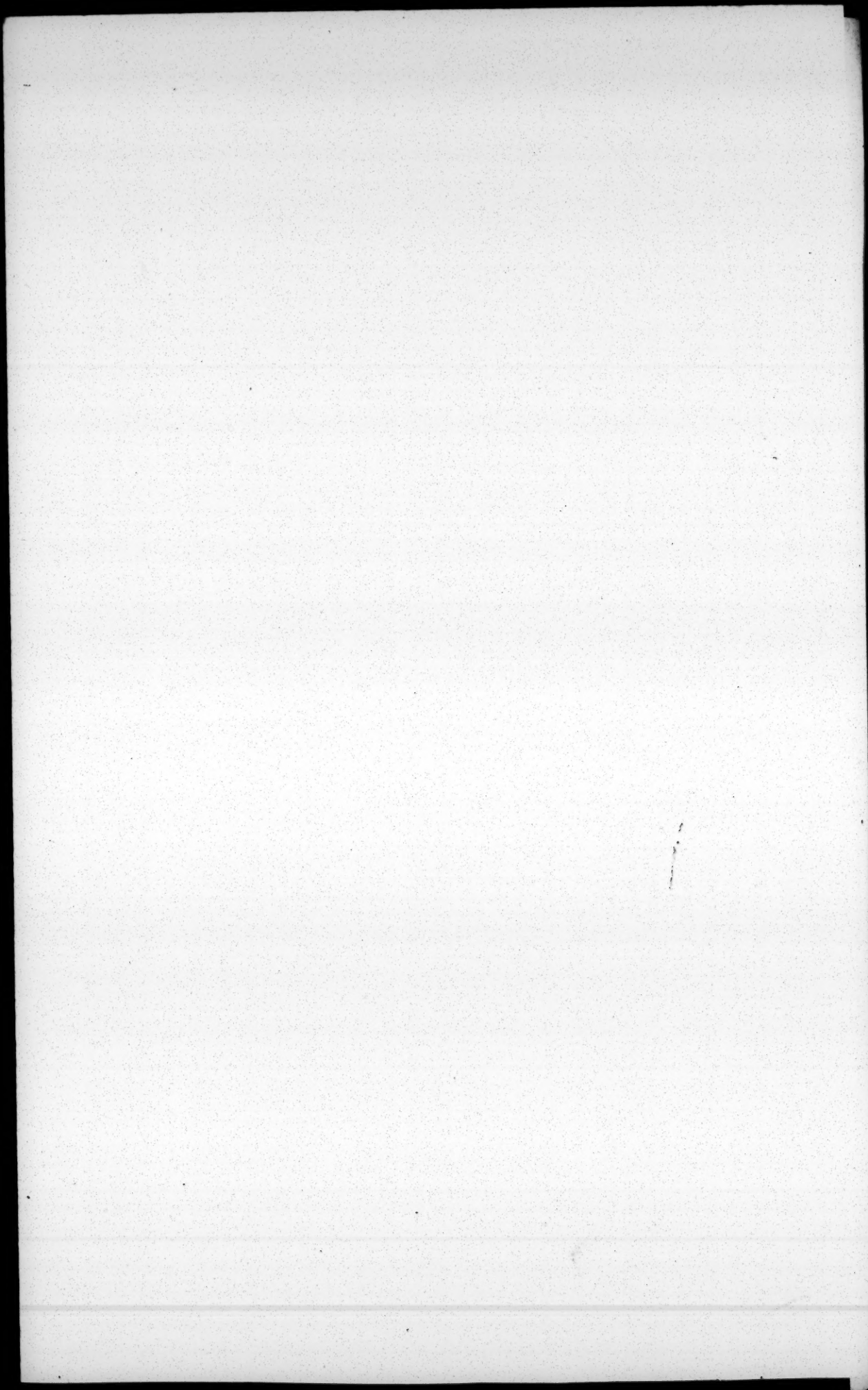


Fig. 27.



Place this facing p. 81.



both of the inferiour and superiour *primary* Planets. CHAP. VI.

It remains only to add somewhat concerning the *secondary* Planets, besides what has been said of them, Chap. I. And the first Particular that deserves Observation, is this, that the like *Phænomena* to those which happen between the Earth and the Moon, happen between *Jupiter* and *Saturn*, and their respective *Satellites*; forasmuch as the said *Satellites* are no other than so many Moons in respect to their respective primary Planet. Hence, whenever either primary Planet so comes between the Sun, and any one of its respective *Satellites*, as to hinder the Rays of the Sun from falling upon it, it suffers an Eclipse. And on the other hand, whenever any *Satellite* comes so between the Sun and its primary Planet, as to intercept the Sun's Rays from its Primary, the said Primary undergoes an Eclipse.

The second Particular worthy of Observation is the *Phænomenon* of *Saturn*, which appears like an *Annulus* or Ring, encompassing *Saturn*, as is represented Fig. 25. From the various

14.
The Satel-
lites of Ju-
piter and
Saturn un-
dergo E-
clipses, &c.

15.
Of the
Annulus or
Anse of
Saturn.

CHAP. ous Position of this *Annulus* in respect
 VI. of the Sun and the Observer, (it being
 w opacous, like *Saturn* it self,) arises the
 several Phases of (what they call) the
Anse of *Saturn*, because they appear
 like the two Handles of a Cup, or the
 like. And this is sufficient to our pre-
 sent Design, concerning the inferiour
 and superiour Planets, as also concern-
 ing the *Satellites* of *Jupiter* and *Sa-
 turn*.



C H A P. VII.

*Of the PHÆNOMENA of the fixed
STARS.*

HAVING shewn how the *Phænomena* CHAP. VII.
of the Sun, and Moon, and pla-
netary Stars may be solved, we are to
proceed next to the Solution of the *Phæ-* I.
nomena of the *fixed Stars*. And these, The fixed
Stars not
subject to
Eclipses.
not borrowing their Light from the
Sun, but shining with their own native
Light, are therefore not subject to any
such Deficiency of Light, as is called
an Eclipse.

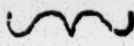
It is indeed observed of (*) some of 2.
the fixed Stars, that they do for a cer- Why some
of them
for a Time
appear,
and then
disappear.
tain Period appear, and then disappear.
Which *Phænomena* is supposed to arise
from the said Stars having some *Maculæ*
or Spots, which move round them in
certain *Periodical* Times : as the Spots
of our Sun are observed to move round

(*) Concerning such fixed Stars, see Dr. Gregory's
Astron. Phys. and Geom. Elem. Lib. 2. Prop. 30

CHAP. it. Nay, it is thought, that the Spots
 VII. do sometimes grow so great, as to quite
 ~~~~~ cover the Star to which they belong,  
 and so to make it disappear altogether;  
 and that this is the Reason, that several  
 fixed Stars observed by the Antients,  
 are now not to be seen. And this Opi-  
 nion is countenanced by the Observa-  
 tions that have been made, that some-  
 times a whole Year together our Sun has  
 shone with a more faint Light than at  
 other Times; this being supposed to be  
 caused by the Spots of our Sun being  
 for that Time grown greater than Or-  
 dinary.

3. As to the fixed Stars appearing of  
 of the dif- different *Magnitudes* or Bigness to us,  
 ferent this is ascribed vulgarly to their being  
 Magnitude really some bigger than others. But the  
 of the fixed more learned in *Astronomy* refer this  
 Stars. apparent Difference of Magnitude only  
 to their different Distances from us.  
 As this Difference of Distance is suffici-  
 ent to make some appear bigger, some  
 lesser; so the Distance of the nearest to  
 us being vastly great, hence our Sense of  
 Vision cannot discern the different Di-  
 stances, and consequently they appear  
 to us as all placed in one and the  
 same



same concave Sphere. By Reason of CHAP.  
their apparent different Magnitudes, they VII.  
are usually distinguished into six Classes,   
being respectively called Stars of the  
*First, Second, &c. Magnitude.*

As to the Rising, Setting, and Re- 4.  
volution of the fixed Stars round the The seem-  
ing proper  
Motion of  
the fixed  
Stars very  
slow. Earth once in 24 Hours, it has been  
above observed, that these *Phænomena*  
may be solved by the diurnal Revolu-  
tion of the Earth round its own *Axis*.  
But besides this apparent diurnal Mo-  
tion, from East to West, the fixed Stars  
seem to have another Motion, where-  
by they seem to move very slowly from  
West to East, or according to the Se-  
ries of the Signs. This Motion is so  
very slow, that it is computed to require  
about 25 or 26 thousand Years for the  
fixed Stars to seem carried thereby  
round the Heavens; whence it is  
stiled (\*) *Annus Magnus*, or the *great*  
*Year*.

---

(\*) It is also stiled *Annus Platonius*, because the Pla-  
tonists teach, that every such Period Things are restored  
to the same State and Condition, as they were so many  
Years afore.

CHAP. VII. This Motion is commonly esteemed as the real proper Motion of the fixed Stars.

~~~~~ But the more learned in *Astronomy* conceive the fixed Stars to have no such real Motion, as for other Reasons, so particularly for this, *viz.* because the said Motion of all the fixed Stars may be more simply, and compendiously solved, by the bare changing of the Places of the *Equinoctial* Points. For it comes to the same, whether we suppose the *Equinoctial* Points to be unmoveable, and the fixed Stars to move forward according to the Series of the Signs; or the fixed Stars to be unmoveable, and the *Equinoctial* Points to be moved backward, or contrary to the Series of the Signs. What has been said, is illustrated, *Fig. 26*, where  $\gamma$   $\ominus$   $\simeq$   $\wp$  represent the *Orbit* of the Earth about the Sun, AEBQ the Earth it self,  $\gamma$  and  $\simeq$  the two *Equinoctial* Points for any one Year. The Earth moving forward again from  $\simeq$  through  $\wp$  towards  $\gamma$ , the Plane of the *Terrestrial Equator* being produced, will pass thro' the Sun (\*) at

5.
The proper
Motion of
the fixed
Stars, not
Real, but
only Appa-
rent; and
whence it
arises.

(*) Note, That these [γ] [$\simeq$] stand for the prick'd γ and $\simeq$ in the Figure, the Types of which could not be had in Time.

[γ ,] be-

[γ ,] before that the Center of the Earth CHAP. comes to γ . And in like manner, the VII. Earth moving forward from γ through ω to α , the Plane of her *Equator* being produced, will pass through the Sun at [α], before that the Center of the Earth comes to α . But the *Equinox* will be then, when the Sun is found in the Plane of the Terrestrial *Equator*; and those Points of the *Ecliptick* are rightly esteemed the *Equinoctial* Points, wherein the Sun is seen at the two *Equinoxes*. Whereas, therefore, γ and α were the *Equinoctial* Points the last Year, the next Year [γ] and [α] will be the *Equinoctial* Points; and so the *Equinoctial* Points will go backwards, considered as to several Years. And by this Change of the *Equinoctial* Points, a fixed Star that keeps its Place at that Point of the *Ecliptick*, which is denoted by γ , and where afore was the vernal *Equinoctial* Point, will now seem to be moved forward from the vernal *Equinoctial* Point to [γ] as much as the interval γ [γ .] Wherefore, this being the most Simple, and consequently most natural Way of solving the *Phænomenon* we are speaking of, it is ge-

CHAP. nerally embraced now a-days. And not
 VII. only so, but it is also (*) mathemati-
 cally demonstrated, for what Reasons
 the *Equinoctial* Points do thus move
 backward, or the *Equator* every Year
 crosses the *Ecliptick* a little sooner or
 forwarder than it did the last Year.
 Whence that which is commonly called
 the *proper Motion of the fixed Stars*, is
 now a-days stiled by the learned in *Astro-*
nomy, the *Præcession* or *Anticipation of*
the Equinoctial Points.

6. It remains only to set down the
 Constellations, whereto the more re-
 markable of the fixed Stars are redu-
 ced. It has been shewn already, what
 are the twelve Constellations or Signs,
 whereby are comprehended the fixed
 Stars that lie in the *Zodiack*. In respect
 of which, the other Constellations are
 distinguished into northern or southern.
 The northern Constellations first distin-
 guished by the Antients, are *the little*
Bear, *the great Bear* (or *Charles-wain*,)
the Dragon, *Cepheus*, *Bootes*, *the nor-*
thern Crown, *Hercules*, *the Harp*, (or
 as it is stiled by some, the *Vultur cadens*,)

*The seve-
 ral Con-
 stellations,
 to which
 the more
 remarka-
 ble fixed
 Stars are
 reduced.*

(*) See Dr. Gregory's *Astron. Lib. 1. Prop. 64.*

the *Swan*, *Cassiopeia*, *Perseus*, *Andromeda*, the northern *Triangle*, the *Charioteer*, the great *Horse* or *Pegasus*, the little *Horse*, the *Dolphin*, the *Arrow*, the *Eagle*, *Serpentarius*, the *Serpent*. To these 21 northern Constellations were afterwards added the Constellations of *Antinous*, *Berenice's Hair*, and (by us *English*) *Charles's Heart*. The southern Constellations known to the Antients are the *Whale*, *Eridanus*, the *Hare*, *Orion*, the greater *Dog*, the lesser *Dog*, the *Ship*, the *Hydra*, the *Crater* or two-handed-Pot, the *Raven* or *Crow*, the *Centaur*, the *Wolf*, the *Altar*, the southern *Crown*, the southern *Fish*. To these 15 are not long since added 12 Constellations, made up of the fixed Stars about the south Pole, and not visible to us, viz. the *Phœnix*, the *Crane*, the *Indian*, the *Peacock*, the *Apus*, the southern *Triangle*, the *Fly*, the *Chamæleon*, the flying *Fish*, the *Toucan* or *American Goose*, the *Hydrus*, the *Dorado*, and the *Royal Oak*.

Besides these Constellations there appears in the Heavens a certain Tract, which goes quite round the Heavens, and from its appearing to be of a milky

7.
of the
milky
Way.

CHAP. Whiteness, is called *Via* (*) *Lactea*, or
 VII. the *milky Way*. It is now, by the Help
 of Telescopes, discovered to be no other than an innumerable Multitude of little fixed Stars.

8. Such fixed Stars as belong not to this
 of the fixed Stars, Milky Way, nor to any of the Con-
 called In- stellations, are called *Informes*, as not
 formes. being yet reduced to any *Form* or I-
 mage, as the Constellations are. And
 so much for the fixed Stars.

(*) It is for the like Reason called *Galaxia* by the
Greeks.



CHAP.

C H A P. VIII.

Of the PHÆNOMENA of COMETS.

T H E R E remains now only the C H A P. *Phænomena of Comets* to be solved, which are spoken of last, because there are not yet such Discoveries made, as afford the like Degree of Certainty in the Solution of the *Phænomena of Comets*, as there is in solving the *Phænomena* of the other Celestial Lights; as also because it is not known yet, whether Comets belong only to this our Solar System, or whether they may not also pass into other of the Mundane Systems, which have the fixed Stars for their several respective Suns.

It is supposed most probable by the Learned in *Astronomy*, that they move in some conick Section, which has the Sun in one of its Focus's. For this Sort of *Orbit* is found best to agree to the Observations that have been made concerning the Motion of Comets. Some indeed have formerly thought,

CHAP. thought, that they move in right
 VIII. Lines; and some Calculations that have
 ~~~~~ been made concerning their Motion,  
 have agreed well enough to this Hypo-  
 thesis. But then it is to be noted, that  
 this will hold the same, although Co-  
 mets move in a conick Section, if so  
 be the Observations be made in that  
 Part of their *Orbits*, which comes very  
 near to a right Line. Let  $APVBC$  in  
*Fig. 27*, be a conick Section very ec-  
 centrical, and let one of its Focus's be  
 $S$  the Center of the Sun. It may be,  
 that the Comet may be observed, whilst  
 it is moving along the Part  $AP$  of its  
*Orbit*; and the rest of the Time,  
 whilst it moves from  $P$  through  $VB$   
 to  $C$ , it may be hid from us by the  
 Rays of the Sun. Or the Comet may  
 be so hid from us, whilst it moves  
 along  $APVB$ , and may be then ob-  
 served, when 'tis come to  $B$ , as it is  
 about to describe the Line  $BC$ . And  
 in both these Cases, the Line descri-  
 bed by the Comet will not be sensibly  
 different from a Right. Moreover,  
 the Comet being observed in  $AP$   
 his Descent towards the Sun, and  
 then drawing daily nearer to the Sun,  
 and

and after that lying hid for some CHAP. Time under the Sun's Rays, and at VIII. Length getting again out of the Sun's Rays on the other Side of the Sun ; hence it comes to pass, that one and the same Comet is looked upon to be two different Ones, which both move only in right Lines, viz. one in AP, the other in BC. Whereas in reality it may be all the while one and the same Comet, whose Trajectory (or Line, which it describes by its Motion) if considered together, both as to its Descent toward the Sun, and also as to its Ascent from the Sun, will hence be found to be no other than a conick Section, as was afore laid down.

Of the three conick Sections, the *Ellipsis* 3. is found most agreeable to the Motion (as of the Planets, so also) of Comets. And it can be no other, if Comets be Bodies of a lasting Substance as are the Planets, and like these have a Periodical Motion round the Sun. If Comets have not such a Periodical Motion, then their Trajectory is Parabolical, or Hyperbolical.

Some



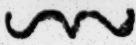
CHAP. Some Comets move like the Planets,  
 VIII. from West to East; some from East to  
 ~~~~~ West; others from North to South, and

4. others lastly from South to North. And
 their *Orbits* as to Greatness, Situation,
 and Inclination, as well in Respect to
 one another, as to the *Orbits* of the
 Planets, are various and different.

*The vari-
 ous Moti-
 ons, &c.
 of Comets.*

5. *Lastly*, A Comet does visibly consist
 of two Parts, one called the *Head*, the
 other called the *Tail*. The Head is the
 Solid Body of the Comet, and is opa-
 cous, as appears from the Shadow it
 casts. The Tail is conceived by the
 Learned to be no other than a thin Va-
 pour arising from the Head by Heat.
 Namely, whilst the Comet is descend-
 ing to its *Perihelium*, those Vapours
 which had afore settled on it, when it
 was in the Regions remotest from the
 Sun, being now rarefied by the Heat of
 the Sun do ascend, *i. e.* fly off that Way
 which is from the Sun. Hence it comes
 to pass, that the Tail of a Comet grows
 greater and greater, as the Comet ap-
 proaches nearer and nearer to its *Peri-
 helium*; and on the other hand, the Tail
 grows less and less, as the Comet goes
 further and further from the Sun; and
 conse-

*Comets
 consist of
 two Parts,
 an Head
 and Tail.*

consequently the Tail is greatest and CHAP.
most shining, presently after the Co- VIII.
met has been most heated in its *Peri-* 
helium. And thus it has been shewn,
how the more remarkable *Phænomena*
of the Celestial Bodies may be solved
or explained according to the *Coperni-*
can Hypothesis.



CHAP.

C H A P. IX.

*A Description of the Celestial (and also
Terrestrial GLOBE.)*

CHAP. IX. **I**N the foregoing Chapters, the Celestial *Phænomena* have been treated of, as considered *in themselves*. I

1. proceed now to treat of them, as they are represented by *artificial Instruments and Machines*, among which the chief is the *Sphere* or *Globe*.

The Celestial Phænomena are represented by artificial Machines, the chief whereof is the Globe or Sphere. The Word *Sphere* we borrow from the *Greek* Language, as we do the Word *Globe* from the *Latin*; each

2. Word, in its respective Language, answering one to the other, and denoting a round Body, that is, according to the Mathematical Definition thereof, a Body from whose inmost Point, called its Center, all right Lines drawn to its Surface are equal one to the other. But the Word *Sphere* is now a-days commonly used to denote a Machine somewhat different from a *Globe*, and more peculiarly

cularly stiled an *Armillary Sphere*; CHAP. IX.
forasmuch as it does not consist of a round continued Surface, but only of some Circles duly placed together, and fancied to resemble *Armillaë*, i. e. Bracelets.

The Sphere and Globe are made to 3.
represent principally such *Phænomena*, Spherical
as arise from the Diurnal Motion. and Theo-
Whence that Part of *Astronomy*, which rical Astro-
treats of the Diurnal Motion, is fre- nomy,
quently stiled (*) *Spherical Astronomy*, what, and
or the *Doctrine of the Sphere*. why so cal-
In like led.
manner, the other Part of *Astronomy*,
which treats of the annual and pro-
per Motion, is stiled *Theoretical Astro-
nomy*, from the Schemes or (as it is
said) little Paper Machines, formerly
made to illustrate the (†) Theory of
the said proper Motion, and thence
called *Theoriæ*.

There are Spheres made agreeable 4.
to the *Copernican Hypothesis*, and The com-
others made agreeable to the vulgar mon Celest-
tial Globe,
how far
useful in
Astronomy.

(*) This makes the first Part in common Astronomical Treatises, and Theoretical Astronomy the second Part.

(†) It is originally a Greek Word, denoting Speculation or Contemplation.

CHAP. or *Ptolemaick* Hypothesis. But the
 IX. former Sort being very costly, and
 ~~~~~ the latter Sort being not of so general  
 Use (even in their own Way, or ac-  
 cording to the *Ptolemaick* Hypothesis)  
 as the Artificial Celestial Globe, hence  
 this is most commonly made use of to  
 illustrate to young Students the Cele-  
 stial *Phænomena*. And when they have  
 been once set right as to the true Sys-  
 tem of the World, and the true  
 Causes of the said *Phænomena*, by ha-  
 ving had the *Copernican* Hypothesis  
 explained to them; then it is allow-  
 able for them to make Use of the com-  
 mon Celestial Globe, though it repre-  
 sents the Celestial *Phænomena*, not  
 according to their *real Nature*, but  
 only according to their *Appearances*:  
 Forasmuch as it is convenient, not to  
 say necessary, in common Discourse to  
 talk of the celestial *Phænomena* accord-  
 ing to the common Notions of them,  
*i. e.* according to their Appearance to  
 our Senses, from which the Vulgar de-  
 rive their Notions.

5. On these Considerations, having in  
 the eight foregoing Chapters of this  
 Treatise explained the real Nature and  
 Causes of the Celestial *Phænomena*, I  
 shall

On ac-  
 count of  
 such its  
 Usefulness,  
 the Cele-

shall in the remaining Part of this Treatise shew, how the said *Phænomena* are represented by the Celestial Globe, as to their Appearance to our Sense. And therefore I shall first (in this Chapter) describe the artificial Celestial Globe, and then (in the following Chapter) shew the Use thereof.

CHAP.

IX.

Among the several Circles belonging to the celestial Globe, I shall begin with the *Horizon*; forasmuch as the artificial *Horizon* is the outermost Circle of the artificial Globe, and that which encloses and upholds all the rest of the said Globe.

6.

*Of the Horizon of the Celestial Globe.*

It has been (\*) afore observed in short that the *Horizon* is so called, as being that Circle which bounds the Sight. To which it is further to be added here, that the *Horizon* is distinguished by *Astronomers* into the *sensible* and the *rational Horizon*.

7.

*The Horizon two-fold, Sensible and Rational.*

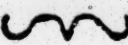
For a right and clear Apprehension of the sensible *Horizon*, it must be called to Mind, that the Sight, if not hindered, extends it self equally every Way.

8.

*The sensible Horizon, what, and why so called.*

(\*) Chap. 2. Sect. 2.



CHAP. Hence (\*) it comes to pass, that, when  
 IX. we stand upon the Surface of the Earth,  
 and the Eye has a free View all round,  
 so much of the Heavens as is seen, ap-  
 pears to us under the Figure of a con-  
 cave Spherical Surface, reaching to the  
 Surface of the Earth. The seeming In-  
 tersection or Meeting of the Surface of  
 the Earth with the fore-mentioned con-  
 cave spherical Surface of the Heavens,  
 being continued every Way round the  
 Eye, represents a Circle, which is cal-  
 led (by a Greek Word) the *Horizon*,  
 because it *bounds* the Sight, and di-  
 vides the seen Part of the Heavens from  
 the unseen; and it is particularly stiled  
 the *sensible Horizon*, because it does thus  
 actually fall under our *Sense* of Vision,  
 when the Eye has a (†) free View.

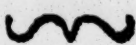
9. The *rational Horizon* is so called,  
 because it falls not under our Sense  
 of Vision, but is only to be conceived  
 by our *Reason*. For hereby is deno-  
 ted that *Horizon*, which would bound

*The ratio-  
 nal Hori-  
 zon, what,  
 and why so  
 called.*

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(\*) See this illustrated, Fig. 1. of my Opticks.

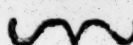
(†) Hence it is observable, that every *Horizon* that  
 actually bounds the Sight, is not properly the sensible  
*Horizon*.

the Sight supposing the Earth bisected, CHAP.  
and one Half of it removed, and the IX.  
Spectator placed on the Center of the   
Earth. What has been said of each  
*Horizon*, is illustrated *Fig. 28*, where  
the greater Circle denotes the Heavens ;  
the little Circle, the Earth ; the Line  
drawn through P, the sensible *Horizon* ;  
the other Line the Rational. Whence  
is also evident, that the sensible *Hori-*  
*zon*, and its respective rational *Horizon*,  
are always parallel one to the other, and  
that their mutual Distance is the Semi-  
diameter of the Earth.

Now the whole Earth being but as 10.  
a *Point* in respect of that vastly dis- *The Earth*  
*but as a*  
*Point in*  
*respect of*  
*the Sphere*  
*of the fixed*  
*Stars.*  
tant Sphere, wherein the fixed Stars  
seem to be all placed ; hence the Dis-  
tance between the rational and sen-  
sible *Horizon*, being no more than the  
Semi-diameter of the Earth, makes  
no sensible or considerable Difference  
as to the *Phænomena* of the fixed  
Stars.

But the Distance between the rati- 11.  
onal and sensible *Horizon*, bears a con- *Of the Pa-*  
*rallax of*  
*the Cele-*  
*stial Lights.*  
siderable Proportion to the Distance  
of the other celestial Lights from  
the Earth, and consequently makes

CHAP. a considerable Difference as to the (\*)

IX. Places of these other celestial Lights,  which are between the Earth and the fixed Stars. This is also illustrated, *Fig. 28*, where the outermost Semicircle represents half the Sphere of the fixed Stars; the other two Semi-circles represent the Halves of the *Orbits* of any two celestial Lights between the Earth and the fixed Stars; and the little Circle about the common Center of the forementioned Semi-circles represents the Earth. The Lines drawn from P (the Place of the Spectator) on the Surface of the Earth, through the Centers of the Celestial Lights M and S, to the Sphere of the fixed Stars, do there denote the *apparent* Places of the said celestial Lights; and the other Lines drawn from the Center of the Earth, through the Centers of M and S, to the Sphere of the fixed Stars, do there denote (what are cal-

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(\*) Here must be remembred what is said, *Chap. I. Sect 15.* viz. That that Point or Part of the Sphere of the fixed Stars, between which and the Spectator any other of the Celestial Lights appears to be, is counted the *Place* of the said Celestial Light.







led) the *true* Places of M and S. CHAP. IX.  
 Whence may be learned, the Reason of thus taking Notice of the Rational *Horizon*, forasmuch as *that* is esteemed by *Astronomers*, the *true* Place of a *Phænomenon*, (where it would be seen to a Spectator placed on the Center of the Earth, *i. e.* where) it is with respect to the rational *Horizon*. Thus T is the true Place of M and S, A the apparent Place of each. The Difference between the true and apparent Place (which are always in the same vertical Circle) of any celestial Light or *Phænomenon*, is called its (\*) *Parallax*.

Having

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(\*) It is a *Greek* Word signifying a *Variation* or *Difference*. It seeming too long a Digression to insert into the Body of this Chapter an Explication of the *Parallax*, and on the other hand, the *Parallax* seeming a Particular too material to be only mentioned, I judged it best to adjoin here by way of Note, what seems requisite to be said of it. The *Parallax* then may be considered, either with respect to different Celestial Lights, or the same. In the former Respect, the *Parallax* is greater or lesser, as the Celestial Lights are less or more distant from the Earth. Thus Fig. 28, the *Parallax* TA of M, is greater than the *Parallax* TA of S. And hence the Moon has the greatest *Parallax*, as being nearest of all the



CHAP. Having shewn the Difference between the sensible and rational *Horizon*, and withal taken Notice, that it

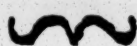
12. is the *rational Horizon*, which is principally regarded by *Astronomers*, it is next to be observed, that accordingly it is the *rational Horizon*, which is principally

The *Horizon* of the *Globe* represents principally the *rational Horizon*.

---

the Celestial Lights to the Earth. In respect of the same Celestial Light, its greatest *Parallax* is at the *Horizon*; and as the Celestial Light ascends higher and higher above the *Horizon*, so its *Parallax* continually decreases, till it quite ceases in the *Zenith* or Vertical Point. For there the two Lines which mark out the apparent and true Place, do fall in together, as is evident from Fig. 28. What more seems requisite to be here observed, is the Angle made by the meeting of the two Lines just mentioned in the Center of the Celestial Light, is called the *Parallaetical Angle*, or the *Angle of the Parallax*, and by it the *Parallax* is measured; as also that the apparent Place is always *lower* or nearer to the *Horizon*, than the true Place. Whence the *Parallax* has a quite contrary Effect to *Refraction*; forasmuch as this causes a *Phenomenon* to appear *higher*, or more above the *Horizon* than really it is. Thus in Fig. 29, let T denote the Earth, surrounded with the Atmosphere AED; S some Star, and O the Spectator on the Surface of the Earth. Were there no Atmosphere, or were it of an equal Thickness with the *Aether*, the Rays of Light would come directly or in a right Line from S to O. But the Rays, when they have passed through the *Aether* SQ, entering at A into the Atmosphere, which is thicker than the *Aether*, hereby is refracted (*i.e.* as it were broken) and bent towards the right Line OP, which is perpendicular to the Surface of the Atmosphere at A. And because  
it

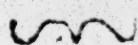
principally represented by the *artificial Horizon* of the Globe; which therefore is (or at least ought to be) so placed, as to divide the Globe it self exactly into two Hemispheres or equal Parts. But here it is to be re-



it is likely, that the Atmosphere it self is not all along, from the *Æther* to the Earth, of an equal Thickness, but is thicker, as it is nearer to the Earth; hence a Ray coming from the Star S will be refracted, not only at A, but also at other Points within the Atmosphere, (as at B, C, &c.) and at each of these Points will be refracted the same Way, *viz.* toward T. But of the Ray A B C O, it is only the last Part C O, which affects the Eye; and therefore the Eye sees the Star at s. and consequently much higher, or much more above the *Horizon* O H, than really it is. But Refraction (as well as *Parallax*) is greater, when the *Phænomenon* is nearer to the *Horizon*; and as the *Phænomenon* ascends higher, it continually decreases, and quite ceases in the *Zenith*. To Refraction it is attributed, that the Sun and Moon appear of an Oval Figure near the *Horizon*. For the upper Rim of the Sun and Moon appearing a little higher, and the lower Rim a great deal higher than it really is, hence this will seem to be nearer to that than it really is; and so the erect or vertical Diameter of either Luminary will seem contracted, while the tranverse or horizontal undergoes no such Contraction, forasmuch as its Extremities are alike elevated by Refraction. 'Tis also to the Refraction of the Sun's Rays to the Atmosphere, that the *Crepusculum* or *Twilight* is owing; for otherwise, as soon as the Sun is set, it would be presently quite Dark. By Refraction also the Sun and Moon appear above the *Horizon*, when their Bodies are somewhat under the *Horizon*.

marked,

CHAP. marked, that although the whole

IX.  broad wooden Circle, which encompasses the rest of the Globe, may sometimes be called the *Horizon* of the Globe, yet properly and strictly it is only the inner Rim or Edge of the upper Surface of the said broad wooden Circle, that is the *Horizon* of the Globe, and (\*) represents the true *Horizon*, whether Rational or Sensible.

13. For the Measuring of the Altitude of Almicantars, the Zenith and Nadir. or Depression of any *Phænomenon*, (i. e. its Distance above or below the *Horizon*, ) here are conceived Circles to run parallel to the *Horizon* through every Point of the Globe; which (as is illustrated, *Fig. 30*,) grow less and less on each Side of the *Horizon*, as they are more remote from it, and at length End in two Points. One of these Points being always over the Ver-

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(\*) The *Horizon* (as is above observed) is that Circle, i. e. that Circular Line, wherein the Surface of the Heavens and the Surface of the Earth intersect, or are conceived to intersect, one the other. But a circular Line has only a circular Length, no Breadth, nor Thickness. And therefore it is properly the inner Edge of the upper Surface of the broad wooden Circle, which is the artificial *Horizon* of the Globe.



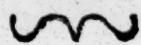
tex, or Head of the Spectator, is there-  
 fore called the *vertical Point*, or by a  
 single *Arabick Word*, the *Zenith*. The  
 other Point, which is diametrically op-  
 posite to the former, is called by an *A-*  
*rabick Word*, the *Nadir*. The *Zenith*  
 is represented, *Fig. 30*, by the Point  
 Z, the *Nadir* by the Point N. The  
 fore-mentioned parallel Circles between  
 the *Horizon* and the *Zenith* or *Nadir*,  
 are called from their Use, *Circles* or  
*Parallels of Altitude*, and by an *Arabick*  
*Word*, *Almicantars*.

For denoting what Point of the  
*Horizon* any *Phænomenon* is in, or is  
 at least to be referred to, there are  
 conceived also Circles crossing every  
 Point of the *Horizon* at right Angles,  
 and all crossing one another in the *Ze-*  
*nith* and *Nadir*. And from their com-  
 mon Intersection being thus in the *Ze-*  
*nith* or vertical Point, they are stiled  
*vertical Circles*, or by an *Arabick Word*,  
*Azimuths*. These are also illustrated,  
*Fig. 30*.

Among the Points of the *Horizon*  
 there are four, which are called the  
*Cardinal* (*i. e.* Principal) Points, and  
 are distinguished by the Names of the  
*East*,

CHAP.

IX.



14.

Of Azi-  
muth's or  
Vertical  
Circles.

15.

Of the four  
Cardinal  
Points of  
the Hori-  
zon.

CHAP. *East, West, North, and South Points.*

IX. The east and west Points of every *Horizon* are those, wherein the Sun rises and sets, when he is in the *Equinoctial*. The other two are each 90 Degrees distant from the former, one towards the north Pole, and thence called the north Point ; the other toward the south Pole, and thence called the south Point.

16. Among the vertical Circles, those two are of special Note, which pass through the Cardinal Points of the *Horizon*. That which passes through the east and west Points is called the *prime Vertical* ; the other which passes through the north and south Points is stiled the *Meridian*, because every Day, when the Sun comes to that Circle, it is then *Meridies* or Mid-day within that *Horizon*. When any Celestial Light is risen, it ascends still higher and higher, till it comes to the *Meridian* ; and as soon as it has crossed that, it begins to descend lower and lower. Hence, when it is at the *Meridian*, it is said to *culminate*, (i. e. to be at its *Culmen* or Top-height for that Day,) and such its  
greatest

greatest Height is therefore called its *me-* CHAP.  
*ridian Altitude.* IX.

As the *Horizon* divides the World  into an upper and lower ( or visible 17.  
and invisible ) Hemisphere ; so the *Me-* The upper  
and lower,  
eastern and  
western  
Hemis-  
pheres,  
what.  
*ridian* divides the World into an east-  
ern and western Hemisphere ; the for-  
mer being so called, because it is that  
wherein the celestial Lights do rise ;  
the other, because it is that wherein  
they set.

Though the whole brass Circle, 18.  
which is immediately upheld by the The Meri-  
dian of  
the Globe,  
what.  
*Horizon* at its north and south Points,  
be frequently called in gross the *Me-*  
*ridian of the Globe* ; yet properly and  
strictly speaking, the artificial *Meridian*  
is only the graduated Edge of the said  
brass Circle.

The *Meridian* is the only vertical 19.  
Circle which is distinctly represented Of the  
Quadrant  
of Alti-  
tude.  
on the Globe. As for all the rest,  
they are represented in Part by the  
*Quadrant of Altitude* respectively ap-  
plied to the Body of the Globe, from  
the *Zenith* to the *Horizon*. It is a  
long narrow Strip of Brass, made  
thin, that it might be pliant to the  
Body of the Globe ; and made to  
reach from the *Zenith* to the *Horizon*,  
so



CHAP. so much of it as is contained between  
 IX. the *Zenith* and *Horizon*, being divided  
 into 90 Degrees, as being just equal to  
 the fourth Part of the Circumference  
 of the Globe; whence it takes the Name  
 of the *Quadrant*, being peculiarly stiled  
 the *Quadrant* of *Altitude*, from its Use  
 in taking the Altitude of any Point of  
 the Globe. And as the Strip of Brass  
 so called does by its Length from the  
*Zenith* to the *Horizon*, represent the  
 fourth Part of a vertical Circle; so be-  
 ing rightly fastned on Top at the *Ze-  
 nith*, and then moved round the Body  
 of the Globe, by such its Motion, the  
 several Points thereof will represent the  
 several Almicantrs between the *Zenith*  
 and *Horizon*.

20. Within the brass Circle called the *Me-  
 ridian* of the Globe, hangs the Body of  
 the Globe, being upheld by two Iron  
 (as it were) Pins fastened to the *Meridi-  
 an*, the Body of the Globe being made  
 to turn round upon these two Pins,  
 which therefore represent the *two Poles  
 of the Equator*, or (as they are otherwise  
 called) of the (\*) *World*; that by the

Of the  
 Axis, and  
 Poles of  
 the World,  
 in the arti-  
 ficial Globe.

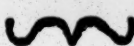
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(\*) They are so called, because all the World, but  
 the Earth, seems to turn round upon them.

little Bear on the Surface of the Globe, CHAP. representing the Arctick or north Pole; IX. and the other, the Antarctick or south Pole. The Piece of Iron passing thro' the Center of the Globe, and of which the two Irons Pins afore-mentioned are the Extremities, represents the *Axis of the World*.

From what has been above said, 21. (Chap. III. Sect. 5.) it is obvious, that the *Equator* of the Celestial Globe is the great Circle, drawn on the Surface of the Globe in the very Middle between the two Poles already mentioned; as also, that the great Circle, which crosses obliquely the said *Equator*, is the *Ecliptick* of the Globe; and that the two lesser Circles, which the said *Ecliptick* touches at its greatest Declination (northward or southward) from the *Equator*, are the two *Tropicks* of the Globe; that on the north Side of the *Equator*, the *Tropick of Cancer*; that on the south Side, the *Tropick of Capricorn*; lastly, that the two lesser Circles drawn on the Surface of the Globe at the same Distance (*viz.*  $23\frac{1}{2}$  Degrees) from each Pole of the *Equator*, as the *Tropicks*

Of the Equator, Ecliptick, two Tropicks, and polar Circles of the artificial Globe.

CHAP. *picks* are from the *Equator* it self, are  
 XI. the *polar Circles* of the Globe; that  
 about the Arctick or north Pole, the  
*Arctick Circle*; that about the Antar-  
 ctick or south Pole, the *Antarctick*  
*Circle*.

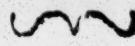
22. In reference to the *Equator*, it is here  
 to be added, that whereas it has been  
 afore in this Chapter, *Seet. 15*, obser-  
 ved, that the east and west Points of  
 any *Horizon* are those, where the Sun  
 rises and sets when he is in the *Equa-*  
*tor*; and whereas also it is then equal  
 Day and Night all over the World; it  
 hence follows, that the artificial *Equa-*  
*tor* in any due Position of the Globe,  
 must cut the *Horizon* exactly in its east  
 and west Points; and there cut it so, as  
 to be equally divided by the *Horizon*  
 into two Parts, one half being above  
 the *Horizon*, the other below. And by  
 these Particulars it may be further pro-  
 ved, whether a Globe is truly made.

23. The Position of the *Equator* to the  
*Horizon*, is in general three-fold. For  
 the *Equator* cuts the *Horizon*, either at  
 right Angles, or at oblique Angles, or  
 else it is *Parallel* to the *Horizon*.

Such



Such as live under the celestial (or CHAP.  
which is the same, upon the terrestrial) IX.

*Equator*, their *Horizon* is crossed by   
the *Equator*, and consequently by all 24.  
its Parallels at right Angles; and <sup>Of a right</sup>  
hence these are said to live in a <sup>sphere.</sup>  
*right Sphere*. The Property of which  
Sphere is this, that it is therein e-  
qual Day and Night through the whole  
Year. For the *Equator* and all its  
Parallels being bisected by the *Hori-*  
*zon* in a right Sphere, (as may be  
shewn by putting the mechanical Globe  
into such a Position, viz. so as that  
the *Equator* of the Globe may move  
round under the *Zenith*,) and the  
Sun's diurnal Motion being always ei-  
ther in the *Equator*, or one of its Pa-  
rallels; hence it follows, that the Sun  
(moving all the 24 Hours alike) must  
always make as long a Stay above, as  
below the *Horizon*, in a right Sphere;  
and consequently, that it must be there  
equal Day and Night through the whole  
Year.

Such as live on either Side the 25.  
*Equator*, between it and its Poles, <sup>Of an ob-</sup>  
their *Horizons* do cross the *Equator*, <sup>lique</sup>  
and consequently its Parallels, at An- <sup>sphere.</sup>  
I gles

CHAP. gles less or more oblique, according as  
 IX. they live less or more distant from the  
 ~~~~~ *Equator*. Hence these are said to live  
 in an *oblique* Sphere, and their *Horizons*,
 though they all bisect or *equally* divide
 the *Equator* it self, yet do all less or
 more *unequally* divide its *Parallels*, ac-
 cording as the *Parallels* themselves, and
 the *Places* to which the *Horizons* res-
 pectively belong, are less or more distant
 from the *Equator*. Wherefore, the di-
 urnal Motion of the Sun, when it is
 not in the *Equator*, being in some one
 of its *Parallels* thus less or more une-
 qually divided by the respective *Hori-
 zons*, it thence comes to pass, that the
 Day and Night are less or more unequal
 at *the same time of the Year* (excepting
 the two *Equinoxes*) in *different Places*,
 according as the said *Places* are less or
 more distant from the *Equator*; and also
 that the Day and Night are less or more
 unequal at *different Times of the Year*
 in the *same Place*, according as the Sun
 is less or more distant from the *Equator*.
 All which is evidently to be shewn up-
 on the Globe.

Lastly,

Lastly, Under the very Poles of the CHAP.
Equator, or of the World, the *Hori-* IX.
zon and *Equator* run parallel one to the other, which Position is therefore cal- 26.
 led a *parallel Sphere*. The property ^{Of a pa-}
 of this Sphere is, that therein it is Day ^{railel}
 for half the Year together, and Night ^{Sphere.}
 for the other half. For the *Equator*
 and *Horizon* being here Parallel, as
 long as the Sun stays on the same Side
 of the *Equator*, so long must it stay
 above the *Horizon* of that Pole, and
 consequently, so long together is it
 Day at the respective Pole, and Night
 at the opposite Pole. This is also
 evidently shewn upon the Globe, being
 placed so, as that its *Equator* and *Ho-*
rizon become parallel one to the other.

It remains to observe in reference 27.
 to the *Equator*, that, a Revolution ^{The Revo-}
 thereof is the Measure of a (*) ^{lution of}
Nuchthemeron, or the Space of 24 ^{the Equa-}
 Hours. Accordingly, whilst any Point ^{tor, the}
 of the artificial *Equator* moves from ^{Measure of}
^{a Nuch-}
^{themeron,}
^{or of 24}
^{Hours,}

(*) It is a Greek Word, signifying the Space of one Day and Night taken together.

CHAP. the artificial *Meridian* round to the
 IX. same Side of the said *Meridian* again;
 ~~~~~ the Index, which is fastened to the  
 north Pole of the Globe, will move  
 quite round the Hour-circle fastened  
 upon the *Meridian* about the said Pole.  
 And by comparing the Motion of the  
*Equator* with that of the Hour-Index,  
 it will sensibly appear, (if the Globe  
 be made true) that as the whole Cir-  
 cumference of the Heavens, divided  
 into 360 Parts, called Degrees, pass  
 under the *Meridian* of any Place in  
 a *Nucthemeron* or 24 Hours; so 15  
 Degrees of the Circumference of the  
 Heavens pass under the same *Meri-  
 dian* every Hour. For according to  
 the Rule of Proportion, as 24 Hours,  
 are to 360 Degrees, so one Hour, is to  
 15 Degrees.

28. Proceed we next to observe in re-  
 ference to the *Zodiack* or *Ecliptick*,  
 that, the Reason, which induced the  
 Old *Astronomers* to divide it into  
 twelve Signs, is thought to be (\*) prin-  
 cipally

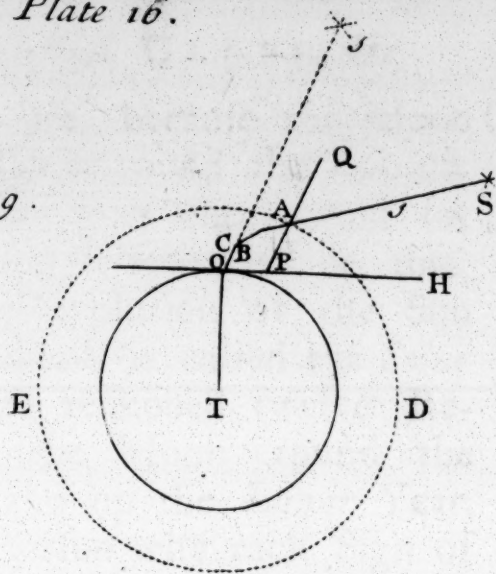
*The Zodi-  
 ack, why  
 divided in-  
 to twelve  
 Signs, and  
 each Sign  
 into thirty  
 Degrees.*

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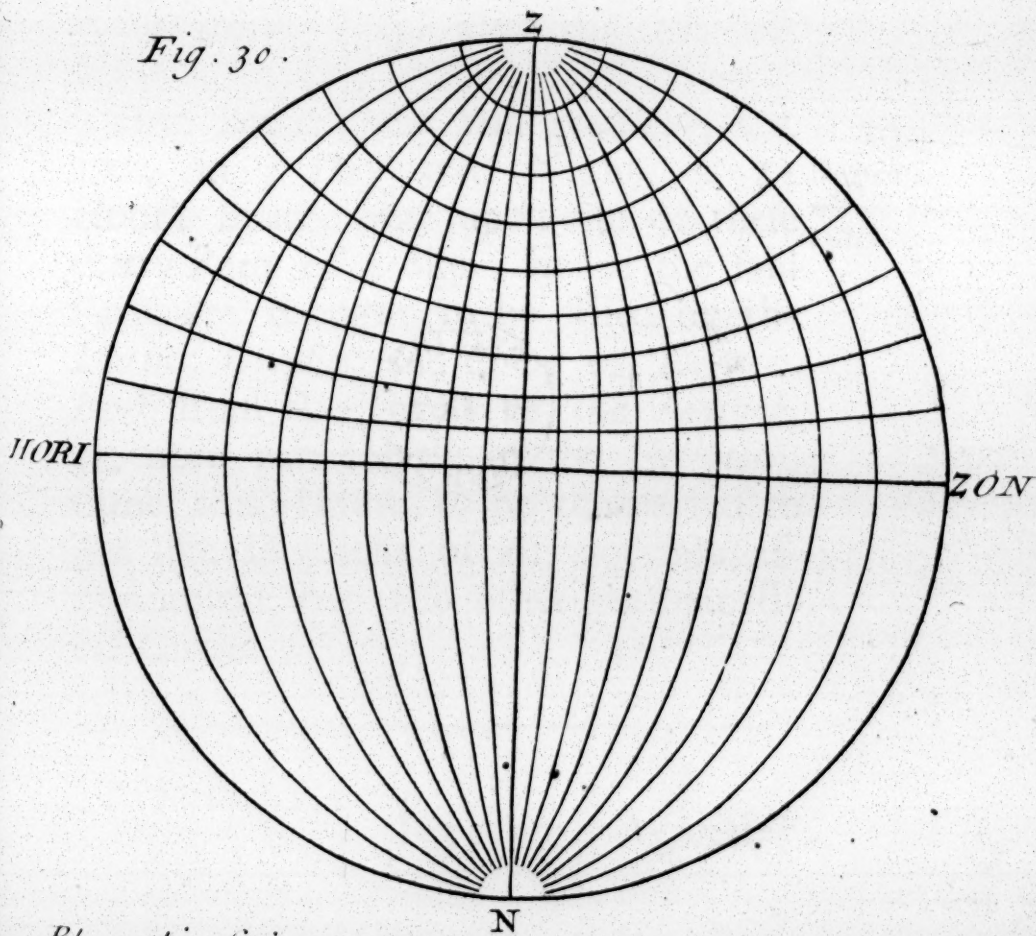
(\*) Some conceive the Reason to have been, because  
 the Number *Twelve* has many aliquot Parts.

*Astronomy Plate 16.*

*Fig. 29.*



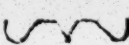
*Fig. 30.*



*Place this facing p. 104*





cipally this; viz. because the Moon CHAP.  
goes twelve Times round the Zodiack, IX.  
whilst the Sun goes once. And for   
the like Reason it seems to be, that,  
whereas one Revolution of the Sun  
round the Zodiack, is called the Solar  
Year, there are reckoned twelve Re-  
volutions of the Moon round the  
Zodiack to make up the Lunar Year.  
Lastly, The Reason why each Sign of  
the Zodiack was distinguished into thirty  
Degrees, seems to be this, because the  
Moon always overtakes the Sun in (\*)  
about thirty Days after she has left  
him.

And because the Sun *graditur*, i. e. 29.  
goes, in a Day and Night or 24 Degrees.  
Hour's Space, near upon one of these <sup>whence so</sup>  
thirty Parts of a Sign; hence the said <sup>called.</sup>  
Parts are thought to be stiled by the  
*Latins*, *Gradus*, and so by us, *Degrees*.  
And from the Circle of the Zodiack,  
or more particularly of the *Ecliptick*,  
came this Name to be transferred to  
the like Divisions of all, not only as-  
tronomical, but also other mathemati-  
cal Circles.

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(\*) See Chap. 4. Sect. 3.

CHAP. Agreeably to the 12 Signs of the  
IX. *Ecliptick*, the Solar Year is also divided into twelve Months, called *Solar*

30. Months; each being the Space where-  
How to find on the Globe, what Sign answers to each Calendar Month.  
 in the Sun goes through a Sign, and so containing almost  $30\frac{1}{2}$  Days. How these Solar Months strictly so called, answer to the common Calendar Month, or (which amounts to the same) what Degree of the *Ecliptick* the Sun is in each Day of the 12 Calendar Months, is to be seen on the upper Surface of the broad wooden Circle of the Globe commonly called its *Horizon*; for thereon the 12 Signs of the *Ecliptick*, and the 12 Calendar Months are so placed, both according to the *Julian* and *Gregorian* Account, as that the Days of these may duly answer to the respective Degrees of those.

13. In reference to the 12 Divisions of the *Ecliptick* on the Surface of the Body of the Globe, it is to be observed, that neither the Constellations themselves, nor their Names, but their Characters shew, which Division of the *Ecliptick* is esteemed respectively to belong to each Sign, or goes under the Name

Name of each Sign. Thus the Character  $\gamma$  is placed at the Beginning of that Division, which is esteemed to belong to *Aries*; and the said Division of 30 Degrees between  $\gamma$  and  $\delta$ , is that which is denoted by the Sign of *Aries*; whereas the Constellation so called, is now, great or most Part of it, out of that Division; and the Word *Aries* is affix'd to the said Constellation almost at the End of the said Division. So the Division between  $\pi$  and  $\sigma$ , is that which is denoted by the Sign of *Gemini*, though the Constellation so called, is almost entirely out of that Division, and consequently, the Word *Gemini* affixed to the Constellation.

The Reason hereof is this. The Constellations themselves (\*) continually (though very slowly) changing their Situation in the *Zodiack* or *Ecliptick*, in Conformity thereto, continually to change the Names of the several Divisions, would create great

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(\*) To what this Change of Situation is owing really, is observed, Chap. 7. Sect. 5.



CHAP. Confusion in *Astronomy* ; forasmuch

IX. as it would make it an intricate Matter rightly to distinguish what Parts of the *Zodiack* belonged to the several Signs in different Ages of the World. Wherefore to avoid such Confusion, it has been with great Prudence judged Expedient, not to make any Change as to the Names of the Divisions, though the Constellations themselves do in Process of Time change their Places ; but always to look on that which is esteemed the first Division of the *Zodiack* as belonging to *Aries*, at least to let it go always under the Name of *Aries*, (and so of the rest) though that Constellation it self (and so of the rest) have now so changed its Situation, as to be mostly, or in great Part out of its respective Division ; and will in Process of Time be removed farther and farther from it.

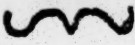
33. Besides the Circles hitherto mentioned, there are usually drawn on the Surface of the celestial Globe, twelve other Circles ; six whereof cross perpendicularly the *Ecliptick* between its Signs, the other six cross perpendicularly

Of the  
twelve o-  
ther Cir-  
cles of the  
Globe, viz.

larly the *Equator* at every like (*viz.* 30 CHAP. IX.  
Degrees) Distance, beginning to reckon  
from the first of *Aries*.

The six former are called Circles of 34.  
*Latitude*, because that Arch of such a <sup>The six</sup>  
Circle, which is intercepted between <sup>Circles of</sup>  
any *Phænomenon* or Point of the Hea- <sup>Latitude.</sup>  
vens and the *Ecliptick*, is the Measure  
of the said *Phænomenon*'s or Point's  
Latitude, *i. e.* Distance from the *Eclip-*  
*tick* northward or southward. For the  
*Ecliptick* being the Circle in the Hea-  
vens of principal Regard, therefore, by  
it the Heavens are distinguished into two  
Hemispheres, one northern, the other  
southern.

By the same Circles is also measu- 35.  
red the *Longitude* of any *Phænomenon* <sup>Which are</sup>  
or Point in the Heavens. For by the <sup>also Cir-</sup>  
Help of these Circles, any *Phænome-* <sup>cles of Lon-</sup>  
*non* in the Heavens is referred to the <sup>gitude.</sup>  
*Ecliptick*, the said *Phænomenon* being  
understood to be in that Point of the  
*Ecliptick*, which is intersected by such  
a Circle passing through the said *Phæ-*  
*nomenon*; and the Arch of the *Eclip-*  
*tick* between the first of *Aries* and  
the said Point of Intersection, is the  
Measure of the said *Phænomenon*'s  
Longitude,

CHAP. Longitude, or Distance from the first of  
IX. *Aries* reckoned according to the Series  
 of the Signs.

36.  
And six  
Circles of  
Declina-  
tion; a-  
mong which  
are the two  
Colures.

By the fix other Circles, any *Phæ-  
nomenon* or Point in the Heavens is re-  
ferred in like manner to the *Equator*;  
and they are called Circles of *Declina-  
tion*, because that Arch of such a Cir-  
cle, which is intercepted between the  
said *Phænomenon* and *Equator*, is the  
Measure of its Declination, *i. e.* of  
its Distance from the *Equator*, north-  
ward or southward. Among these  
Circles, the two of chief Note are  
the two (\*) *Colures*; one whereof cros-  
ses the two *Equinoctial* Points, and is  
therefore called the *Equinoctial* Colure;  
the other crosses the two *Solstitial* Points,  
and is therefore called the *Solstitial* Co-  
lure.

37.  
The princi-  
pal Circles  
of the  
Globe, usu-  
ally recko-  
ned Ten,  
and distin-  
guished in-  
to six grea-  
ter, and  
four lesser  
Circles.

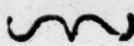
And thus we have described the  
several Circles, and more remarkable  
Points of the Celestial Globe. It re-  
mains to observe, that of all the fore-  
mentioned Circles, these are usually

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(\*) The Import and Reason of this Name is not  
well accounted for by any Writer of *Astronomy*, as I  
know of.

reckoned



reckoned the ten principal Circles of CHAP.  
 the Globe, viz. the *Horizon*, the IX.  
*Meridian*, the *Equator*, the *Zodiack*   
 or *Ecliptick*, the two *Colures*, the two  
*Tropicks*, and the two *Polar* Circles.  
 And these are distinguished into *greater*  
 and *lesser* Circles; the six former  
 being greater Circles, as being con-  
 centrical with the Globe it self, and  
 so dividing, each of them, the Globe  
 into two Hemispheres or equal Parts;  
 the four latter being lesser Circles,  
 as being not concentrical with the  
 Globe, and so dividing, each of  
 them, the Globe into two unequal  
 Parts.

All the ten Circles last mentioned, 38.  
 are usually drawn on the terrestrial Of the  
 terrestrial  
 Globe.  
 Globe; as also Circles crossing per-  
 pendicularly the *Equator* at every ten  
 Degrees, and other Circles running  
 parallel to the *Equator* at every ten  
 Degrees. The former are called Cir-  
 cles of *Longitude*, the latter Circles  
 or *Parallels* of *Latitude*; forasmuch  
 as those serve to shew the Longitude  
 of Places, (i. e. their Distance from  
 some one of the said Circles taken at  
 Liberty, and commonly called the  
 first

CHAP. first *Meridian*, all these Circles of  
 IX. Longitudes being also *Meridians*; )  
 ~~~~~ these serving to shew the Latitude of  
 Places, or their Distance from the
Equator. Besides these Circles fore-
 mentioned, there are also usually
 drawn on the Surface of the terre-
 strial Globe, *Rumbs*, i. e. Circles
 crossing one another in some certain
 Points of the Globe, where there is a
 Vacancy, and representing the sever-
 al Winds, or 32 Points of the Com-
 pass, set down also on the outward
 Rim of the *Horizon*, both of the ce-
 lestial and terrestrial Globe. But the
 main Difference between these two
 Globes, is this, that on the Surface of
 the celestial Globe are described the
 Constellations, and other fixed Stars in
 their due Situation: on the Surface of
 the Terrestrial Globe are described the
 several Parts of the Earth and Sea in
 their due Situation.

39. Proceed we now to the Use of the ce-
 lestial Globe, or to shew how the diur-
 nal *Phænomena* of the celestial Lights
 are represented thereby. For the clearer
 Apprehension whereof it seems requisite
 to observe, that there is this Difference

An Obser-
 vation con-
 cerning the
 Difference
 between
 the natural
 Appear-

in general between the natural Appearance of the celestial Lights, and the artificial Representation of them by the

CHAP. IX.

Globe, viz. that the said celestial Lights do naturally appear to us as in the

rances of the celesti-

cave, or inner Surface of the Heavens, whereas they are represented upon the

al Lights, and the ar-

Convex or outer Surface of the celestial

tificial Re-

Globe. Wherefore to make the artificial Representation to answer more exactly

on of them upon the celestial

Globe.

to the natural Appearance, either the Spectator must be conceived to be placed

within the celestial Globe at its Center,

and the Body of the Globe to be transparent like the Heavens, and in such a

Position of the Eye, the celestial *Phæ-*

nomena on the Surface of the Globe will appear to the Eye in a concave Surface,

as they do naturally ; or else the Spectator is to be conceived as placed with-

out the concave or inner Surface of the Heavens ; and consequently as viewing,

from somewhere above, the correspondent convex Surface of the Heavens ;

and upon such a Supposition, the celestial *Phænomena* would naturally ap-

pear to us in a convex Surface, as they are represented by the Globe. Now we

being placed upon the Convex, or outer Surface of the Earth, and the fe-

veral

CHAP. veral Parts of the Earth and Sea being
IX. represented likewise on the convex Sur-
face of the terrestrial Globe; therefore
there is an exact Agreement in this Particular between the natural Position of the several Parts of the Earth and Sea, and their artificial Representation by the terrestrial Globe, without the Help of any such Fiction, as has been afore observed requisite, to adjust the natural Appearance of the celestial *Phænomena*, to their artificial Representation by the celestial Globe.



C H A P. X.

*Of the more useful Problems solved by
the Celestial GLOBE.*

P R O B L E M I.

*To find the Sun's PLACE in the
ECLIPTICK for any Day given,
v. g. Oct. 13. Old Style.*

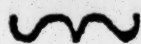
IN the *Julian* Calendar (placed next C H A P. X.
to the *Ecliptick*) on the *Horizontal*
wooden Circle of the Globe find the
Day given, to which adjoins the Degree
of the *Ecliptick*, where the Sun is that
Day. Thus to *Oct. 13*, adjoins the first
Degree of *Scorpio*, the Sun's Place for
that Day.

The Sun's Place being thus found by the *Ecliptick* on
the *Horizon*, the same Degree of the *Ecliptick* on the
Surface of the Globe is to be taken, in order to solve
any of the following Problems.

P R O-

CHAP.
X.

P R O B L E M II.



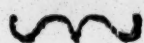
To find the Sun's DECLINATION at any Time given, v. gr. Oct. 13. Old Style.

HAVING (by *Problem I.*) found the Degree of the *Ecliptick*, wherein the Sun is at the Time given, bring the said Degree to the graduated Edge of the *Meridian* of the Globe; the Degrees of the said *Meridian*, intercepted between the *Equator* and the Sun's Place, shews the Sun's Declination. Thus, Oct. 13. the Sun is in the eleventh Degree of the southern Declination.

As in this, so in the following Problems, by bringing any Point of the Globe to the *Meridian*, is understood the bringing it to the graduated Edge of the *Meridian* of the Globe, as being that which represents the true *Meridian*.

In like manner, the *Latitude* of a Place is found upon the terrestrial Globe, by bringing the Place to the graduated Edge of the *Meridian*, and reckoning the Degrees of the *Meridian* between the Place and the *Equator*. For as the Distance of any Point in the Heavens from the *Equator* is *Astronomical Declination*, so the Distance of any Point on the Earth from the *Equator* is *Geographical Latitude*. Which is requisite to be here known, forasmuch as although the two foregoing Problems respect indifferently all Latitudes and Places, the following Problems respect only particular Places, the *Phænomena* relating thereto varying according to the different Latitude of Places.

P R O-

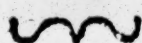


PROBLEM III.

To rectify the GLOBE to any Latitude given.

MOVE the respective Pole (*viz.* the north Pole, if the Latitude given be northern; the south Pole, if southern) above the *Horizon*, till there are so many Degrees of the *Meridian* between the said Pole and the *Horizon*, as answer to the Latitude given. Thus the north Pole being elevated 51 Degrees and an half, the Globe is rectified for the Latitude of *London*.

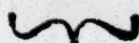




PROBLEM IV.

To find what STARS never rise, or never set in any Place or Latitude given.

THE Globe being (by *Problem 3.*) rectified to the Latitude given, such Stars as go not under the *Horizon* of the Globe, during its whole Revolution, they never set in the Latitude given. And such Stars as rise not above the *Horizon* of the Globe, during its whole Revolution, they never rise in the Latitude given. Thus the little *Bear*, the *Dragon*, *Cepheus*, and *Cassiopeia*, never set in the Latitude of *London*; as also the great *Bear*, except the lower Part of its right Foot. On the other hand, the *Peacock*, the *Indian*, the *Toucan*, the *Hydrus*, the *Dorado*, the *Chamæleon*, the southern *Triangle*, the *Apus*, never rise in the Latitude of *London*.



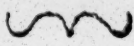
PROBLEM V.

To rectify the GLOBE, so, as that it may be ready duly to represent the diurnal PHÆNOMENA, at any Place, and Time given, v. gr. at London, Oct. 13. Old Style.

THE Globe being rectified (by *Problem 3.*) to the Latitude of the Place given, bring the Sun's Place in the *Ecliptick* for the Day given (found by *Problem 1.*) to the *Meridian*, and make the Hour-Index to point just to 12 on the Hour-Circle. The Globe in such its Position will actually represent the Position of the Heavens, in Respect of the Place given, at the *Noon* or 12 a Clock of the Day given. And consequently by the due Motion of the Globe, may be represented the Position of the Heavens, in Respect of the Place given,

CHAP. ven, at any other Part of the Day
X. given.

Thus the north Pole being elevated $51\frac{1}{2}$ Degrees, which is the Latitude of *London*, and the first Degree of *Scorpio* (which is the Sun's Place, *October* 13. Old Style,) being brought to the *Meridian*, the Globe will represent the Position of the Heavens in Respect of *London*, at Noon, *October* 13. Old Style; that is, such Stars as are at or near the *Meridian* or *Horizon* (&c.) of the Globe, will then be respectively at or near the *Horizon* (&c.) of *London*. And consequently by the due Motion of the Globe, may be represented the Position of the Heavens in Respect of *London*, at any other Hour of the same Day; and thereby may be found the Time of the Sun's Rising or Setting, &c. that Day, as is shewn in the following Problems. Only it must be remembered, that in Order to solve such Problems, as relate to the Time of any such *Phænomenon*, the Hour-Index must always be put exactly to 12 on the Hour-Circle, before the Sun's Place be moved from the *Meridian*;

dian; and also special Care must be CHAP.
 taken, that the Hour-Index moves X.
 duly round with the Body of the 
 Globe.

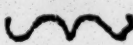
PROBLEM VI.

*To find the Time of the SUN's Rising
 and Setting, and its Amplitude, at
 any Place or Time given.*

THE Globe being (by *Problem 5.*)
 duly ordered and prepared, turn
 the Globe, till the Degree of the
Ecliptick, wherein the Sun is for the
 Day given, comes to the East-Side of
 the *Horizon*; the Hour-Index will then
 shew upon the Hour-Circle the Time
 of the Sun's Rising: and the Degrees
 of the *Horizon*, intercepted between
 the true east Point, and that Point of
 the *Horizon* the Sun's Place comes to,
 shew its Morning *Amplitude*, this being

CHAP. the Distance of the Point of the *Horizon* where the Sun rises, from the true east Point of the *Horizon*. In like manner, the Degree of the *Ecliptick*, wherein the Sun is, being brought to the west Side of the *Horizon*, the Hour-Circle will shew the Time of the Sun's Setting; and the Degrees of the *Horizon*, intercepted between the true west Point, and that Point of the *Horizon* which the Sun's Place is brought to, shew its Evening *Amplitude*, or how far the Sun sets distant from the true west Point. Where it is to be noted, that the Sun sets so long before or after six in the Evening, as it rises after or before six in the Morning; and in like manner, the Sun sets so far distant (northward or southward, according to the respective Time of the Year) from the true west Point, as it rises from the true east Point.

Thus it will be found by the Globe, that at *London*, *October 13.* the Sun rises much about 7, and sets much about 5 a Clock; as also, that its *Amplitude* is 18 Degrees, the Sun rising so many Degrees to the South of

of the true east Point, and setting so CHAP.
many Degrees south of the west X.
Point. 

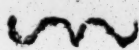
The Time of the Sun's Setting, being doubled, will give the Length of the Day; and the Time of the Sun's Rising, being doubled, will give the Length of the Night. Thus, *Octob. 13.* the Day in the Latitude of *London*, is much about 10 Hours long; and the Night much about 14 Hours long.

P R O B L E M V I I .

To find the Time of the SUN's Rising and Setting by its Ascensional Difference.

THAT Degree of the *Equator*, which, reckoned from the Beginning of *Aries*, rises or sets with
K 4 the

CHAP. the Sun in a right Sphere, is called

X. the Sun's *right Ascension*. And that
 Degree of the *Equator*, which, reckoned in like manner, rises or sets with the Sun in an oblique Sphere, is called the Sun's *oblique Ascension*. And the Difference between its right and oblique Ascension, is called its *ascensional Difference*.

The oblique Ascension of the Sun is found (the Globe being first rectified by *Problem 5.*) by bringing the Sun's Place to the East or West Side of the *Horizon*, and there noting what Degree of the *Equator* comes to the same Side of the *Horizon*, together with the Sun. The right Ascension of the Sun, is likewise found by (putting the Globe into a right Sphere, and then noting what Degree of the *Equator* comes together with the Sun to the same Side of the *Horizon*; or more readily and without changing the Globe from an oblique into a right Sphere, by) noting what Degree of the *Equator* comes up to the *Meridian*, together with the Sun: (for the *Equator* always cuts the *Meridian* at right Angles, as it does the *Hori-*

zon in a right Sphere; and consequent-
 ly, the same Degree of the *Equator*,
 that would come, together with the
 Sun, or any Degree of the *Ecliptick*,
 to the *Horizon* in a right Sphere, will
 come, together with the Sun, to the
Meridian in any oblique Sphere.) The
 quantities of the right and oblique
 Ascension being thus found, the ascen-
 sional Difference is found by subtract-
 ing the lesser out of the greater:

Now the right Ascension of the Sun
 being that Degree of the *Equator*,
 which rises and sets with the Sun in
 a right Sphere, *i. e.* to such as live just
 under the Celestial (or upon the Ter-
 restrial) *Equator*, to whom the Sun al-
 ways rises at six, and sets at six; hence
 the ascensional Difference (turned into
 Time by reckoning one Hour for every
 15 Degrees, and so proportionably) shews
 how long the Sun rises and sets afore or
 after six, according to the Time of the
 Year.

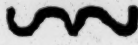
Thus

CHAP. Thus the Sun's right Ascension,
 X. *October* 13. is much about 208; and
 his oblique Ascension on that Day in
 Respect of *London*, is much about
 223; and consequently, the ascensio-
 nal Difference is 15, which answers
 to one Hour in Time. Wherefore, the
 Time of the Year considered, the Sun
 rises much about an Hour after six, *i. e.*
 much about seven; and sets much about
 an Hour before six, *i. e.* much about
 five; agreeably to what was found by
Problem 6.

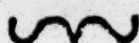
P R O B L E M V I I I .

*To find the S U N's Altitude at any Place
 and Time given.*

THE Globe being rectified by *Pro-
 blem* 5th, the Degrees of the *Meri-
 dian* reckoned from (the South Side of)
 the *Horizon* to the Sun's Place, give
 the Sun's *Meridian* Altitude. Thus,
October

October 13. the *Meridian* Altitude of CHAP.
the Sun at *London*, will be much about X.
27 Degrees. 

The Altitude of the Sun is found at any other Time of the Day given, by turning the Globe (rectified also by *Problem* 5.) till the Hour-Index points to the Time assigned; and then fastening the Quadrant of Altitude on to the *Meridian* at the *Zenith*; (i. e. at so many Degrees from the *Equator*, as is the Latitude of the Place given;) and bringing the said Quadrant so fastened to the Sun's Place in the *Ecliptick*: the Degrees intercepted on the Quadrant between the Sun's Place and the *Horizon*, shew the Sun's Altitude at the Time assigned. Thus, *Octob.* 13. the Sun's Altitude at nine in the Morning, will be about 17 Degrees in Respect of the *Horizon* of *London*. And the same will be its Altitude at three in the Afternoon. For it is to be noted, that at Times equally distant (before and after) from 12, the Sun's Altitude is also equal.



PROBLEM IX.

To represent the Face or Appearance of the Heavens, or to shew the Situation of the fixed Stars, at any Time of the Night, in Respect of any Place and Night given.

THE Globe being rectified by *Problem 5th*, and (by the Needle) set so, as that its cardinal Points answer the cardinal Points of the Compass, turn the Globe till the Hour-Index points to the time of the Night assigned. Such Stars as appear at or near the *Meridian* or *Horizon* (and so of any intermediate Point) of the Globe, will appear likewise at or near the *Meridian* or *Horizon* of the Place given; (and so of any intermediate Point in the Heavens.)

Thus,

Thus, *Octob.* 13. at Ten at Night, CHAP. X.
the glorious Constellation *Orion* will appear on the East Side of the *Horizon* of *London*; the Star *Rigel* in the left Knee of *Orion* being just at the *Horizon*; the three Stars in the same Constellation, called by our common People the *Yard*, a little above the *Horizon*. About twenty Degrees (on a vertical Circle) above the uppermost of these appears the bright Star in *Taurus*, called *Aldebaran*, and the *Bull's Eye*; and somewhat above this in the same Constellation, the Celebrated Stars called the *Hyades*, and the *Pleiades*, these being in the Back, those in the Forehead of *Taurus*. Just under the *Meridian* Southward appears the Star called *Andromeda's Head*, and at or near the *Meridian* the Constellations of *Cassiopea*, *Cepheus*, *Pegasus*, &c. Between the *Meridian* and the West Side of the *Horizon* appears the Constellations of the *Swan*, *Harp*, &c. And at or near the West Side of the *Horizon*, the Constellations of *Antinous*, *Serpentarius*, the northern *Crown*, &c.

Hence

CHAP. Hence it is obvious, that this Problem is of good Use to find out and know the several Constellations, and the more remarkable Stars in each Constellation.

PROBLEM X.

To find the Hour of the Night, the Altitude of any Star being given, or first found by some Instrument for that Purpose.

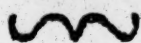
THE Globe being rectified according to *Problem 5.* and the Quadrant of *Altitude* duly fixed to the *Meridian*, move the Globe till the said Quadrant cross the Star in the given *Altitude*; then the *Hour-Index* will shew the Hour of the Night.

Thus,

Thus, *Oſob.* 13. the Altitude of *Al-CHAP.*
debaran, or the Bull's Eye, is found to X.
be 27 Degrees, 30 Minutes. Where-
fore moving the Globe till the Quadrant
of Altitude croſſes the ſaid Star in $27\frac{1}{2}$
Degrees of Altitude, the Hour-Index
will then point to Ten at Night.

Here it is obvious, that if the Star be
in the *Meridian*, then there is Occaſion
only to turn the Globe (rectified by
Problem 5.) till the ſaid Star comes to
the *Meridian* of the Globe: for then
the Hour-Index will ſhew the Hour.





P R O B L E M XI.

To find the Beginning of the (Crepusculum, i.e.) Twilight, or the Time of the Day-break, at any proper Time of the Year.

THE Globe being (by *Problem 5.*) rectified, elevate that Degree of the *Ecliptick*, which is diametrically opposite to the Sun's Place at the Time given, 18 Degrees above the West Side of the *Horizon*; and the Hour-Index will shew the Time sought. Thus, *October 13.* Day breaks, or the Twilight begins about a Quarter before five at *London.*

The Reason of elevating the Degree of the *Ecliptick*, diametrically opposite to the Sun's Place, 18 Degrees above the West Side of the *Horizon*, is this; because, thereby the Degree of the *Ecliptick* wherein the Sun is at the Time given, is depressed 18 Degrees below the East Side of the

the *Horizon*. At which Depression it is CHAP. observed by *Astronomers*, that the morn- X.
 ing Twilight begins; as also, that the evening Twilight ends at the like Depression of the Sun, under the west Side of the *Horizon*. Whence it is obvious, that the Beginning of the morning Twilight being found, it is obvious to know, when the evening Twilight ends; this ending so much after or before six in the Evening, as that begins before or after six in the Morning. Thus, *October* 13. the evening Twilight ends about a Quarter after seven, at *London*, or any Place in the same Latitude.

It is to be further noted, that the morning Twilight beginning, when the Sun is 18 Degrees below the east Side of the *Horizon*; and the evening Twilight ending, when the Sun is 18 Degrees below the west Side of the *Horizon*, it thence follows, that, during that Part of the Year, wherein the Sun's Depressiion is never so much as 18 Degrees, there is no Beginning of the morning Twilight, or Ending of the evening Twilight, but one continued Twilight from Sun-setting to Sun-rising.

L

CHAP. sing. Now that Part of the Year, where-
 X. in there is such a continued Twilight in
 the Latitude of *London*, is while the
 Sun is passing from about the fifth De-
 gree of *Gemini*, to the twentieth of
Cancer, i. e. from about the 15th of
May, to about the 7th of *July*. For
 during this Space, the Sun is never de-
 pressed 18 Degrees below the *Horizon*.

PROBLEM XII.

*To find the Longitude and Latitude of
 any Star given.*

LAY one End of the Quadrant of
 Altitude upon the proper Pole of
 the *Ecliptick*, (viz. if the Star be in
 the northern Hemisphere of the Heavens,
 upon the north Pole; otherwise, on
 the south Pole,) and the graduated
 Edge thereof upon the Center of the
 Star, so will the Quadrant cut the *E-*
cliptick

cliptick in the Star's *Longitude*, (i. e. CHAP. its Distance from the first of *Aries*,) and X. the Degrees of the Quadrant intercepted at the same Time, between the Star, and the *Ecliptick*, will give its *Latitude*, this being no other than the Star's Distance from the *Ecliptick*. Thus the Longitude of the Star called *Lucida Lyræ*, will be found to be 283 Degrees, and its Latitude about 60 Degrees Northwards.

It is obvious, that the Sun, being always in the *Ecliptick*, never hath any Latitude; and its Longitude is found without any more ado, than by computing the Number of the Degree it is in from the first of *Aries*. Thus, *October* 13. the Sun is in the 190th Degree of *Longitude*, that being the Distance or Number of the first Degree of *Scorpio*, where the Sun then is, from the first of *Aries*.

There are some other Problems, which may be solved by the Globe; but they being of little Use are here omitted. And so we are come to the End of this Astronomical Treatise,

L 2

wherein

CHAP. wherein are contained such Particu-
X. lars, as seem more useful to be known
~~~~~ by Young Students, especially Young  
Gentlemen, at their first Institution in  
*Astronomy.*

*F I N I S.*



THE

T H E  
Young Gentleman's  
CHRONOLOGY,

Containing such  
Chronological ELEMENTS,  
as are most useful and easy to  
be known.

---

B Y  
EDWARD WELLS, D. D. late  
Rector of Cotesbach in Leicestershire.

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*The* FOURTH EDITION.

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L O N D O N :

Printed for JAMES, JOHN, and PAUL  
KNAPTON, at the Crown in Ludgate-Street.  
M DCC XXXVI.







T H E  
P R E F A C E.



*H E Art of Chrono-  
logy has so close a  
Dependance upon Af-  
tronomy, that it is  
not usual for Writers of Astro-  
nomical Treatises to comprise  
L 4                      therein*

## The P R E F A C E

*therein a great deal of what more properly belongs to Chronology ; and which therefore I have here laid together, with the other most useful and easy Elements of Chronology, in a distinct Treatise from my Astronomy. But the Design both of the One and the Other being the same, as therefore I have given my Astronomical Treatise the Title of The Young Gentleman's Astronomy, so I have given this my Chronological Treatise the Title of The Young Gentleman's Chronology : nothing being here insisted on, but what relates to the common ( Civil or Ecclesiastical ) Computation of Time, and to the two*  
Cele-



## The P R E F A C E.

*Celebrated Era's of the Olympiads, and the Building of Rome, the former chiefly used by Greek Historians, the latter by Roman.*



THE



T H E  
C O N T E N T S.

---

C H A P. I.

**O** *F a Day ; and the Parts of Time  
arising from a Day by Division,  
viz. Hours and Minutes, Page 1*

C H A P. II.

*Of the several Parts of Time, which  
arise from a Day by Collection, viz.  
Weeks, Months, and Years. 9*

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74



THE



T H E  
 Young Gentleman's  
 CHRONOLOGY, &c.



C H A P. I.

*Of a DAY; and the Parts of Time arising from a Day by Division, viz. Hours and Minutes.*

**B**Y (\*) CHRONOLOGY is understood the Art or Skill of adjusting Things past to their proper Times. C H A P. I.

Hence Chronological Institutions consist of the Explication of the several

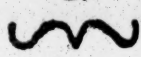
- I. Chronology, *what.*
2. Distinguished into two Parts.

---

(\*) The Word *Chronology* denotes literally in the Greek Language a *Discourse*, or *Account of Time*, being compounded of χρόν *Time*, and λόγ *a Discourse or Account*.

*Parts,*

CHAP. *Parts*, into which Time in general is

I. divided; and of the several *Characters*,  
 by which particular Times are distinguished one from another.

3. The several Parts of Time are, *Minutes, Hours, Days, Weeks, Months, and Years*. Amongst which we shall speak first of a Day, because from it arise the other Parts of Time, considered as they are applied to common Use. For as Hours and Minutes arise from a Day by Division and Subdivision; so Weeks, Months, and Years arise from a Day by Collection, or reckoning such or such a Number of Days together.

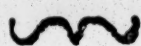
4. By a *Day* then, according to the primary (\*) Intention of the Name, is denoted the Time of Light; and in this Sense it is opposed to Night, or the Time of Darknefs. And the Sun being made to (†) *rule the Day*, hence a Day, according to the primary Intention of the Name seems most properly and naturally to be determined

---

(\*) God called the Light Day; and the Darknefs he called Night, Gen. i. 5.

(†) God made two great Lights; the greater Light to rule the Days, Gen. i. 16.



by the Sun's Rising and Setting; and CHAP. I.  
 so to be most properly and naturally defined, the Stay of the Sun above   
 the Horizon, or the Time between  
 the Sun's Rising and Setting. Agree-  
 ably whereunto, Night is the Stay of  
 the Sun below the Horizon, or the  
 Time between the Sun's Setting and  
 Rising.

But the Word *Day* is frequently ta- 5.  
 ken in a larger Sense, so as to compre- *Another*  
 hend also the Night, and to denote a *Acceptati-*  
 whole Revolution of the Sun round *on of a*  
 the Earth. This Sort of Day is most *Day for a*  
 aptly denoted by the Greek Word (\*) *Nuchthe-*  
*meron, or*  
*24 Hours.*  
*Nuchthemeron.*

The *Nuchthemeron* may be reckon- 6.  
 ed, either from Sun-setting to Sun- *Different*  
 setting, as did the *Jews* and *Athenians*, *ways of*  
 and as the *Italians* still do; or from *computing*  
 Sun-rising to Sun-rising, as did the *the Nuch-*  
*themeron.*  
*Babylonians*; or from Mid-day to  
 Mid-day, as do the Generality of

---

(\*) It is a compound of *νύξ* a Night, and *ἡμέρα* a Day. The two-fold Acceptation of the Word *Day*, is distinguished usually by the Names of a *Natural* and an *Artificial* Day. But some calling that a natural Day, which others call an Artificial, hence arises great Confusion; to avoid which I judge it best, wholly to omit this Distinction.

CHAP. Astronomers, and likewise the *Arabs*; or lastly, from Mid-night to Mid-night, as did the old *Egyptians*, and *We* of this Island, together with the *French*, *Germans*, and other *Europeans*, still do.

7.  
Of an  
Hour.

Proceed we now to the Part of Time, called an *Hour*. And hereby is principally denoted the 24th Part of a *Nuchthemeron*. Now a *Nuchthemeron* being the Space of an entire Revolution of the Sun about the Earth, during which the Equator makes also an (\*) entire Revolution, hence it

---

(\*) In strictness the Equator makes somewhat more than one Revolution, during a *Nuchthemeron*; viz. so much more as answers to the Sun's apparent proper Motion in the Ecliptick during the said Space of Time. Now this Overplus being various; viz. 57 Minutes in the Sun's Apogee, and 61 Minutes in its Perigee, hence Astronomers take the Mean between the two fore-mentioned Numbers for a standing Measure through the whole Year, and so compute that to every *Nuchthemeron* there answers 59'. 8", and almost 20", over and above a Revolution (or the 360 Degrees) of the Equator. But now the Difference between the Sun's Revolution (or a *Nuchthemeron*) and the Equator's, when at greatest, being but 61 Minutes, or a little more than a Degree, which answers but to a little more than 4 Minutes in Time, hence it may be passed over unregarded in common Use; and the Hour here spoken of may be well enough esteemed to answer just to 15 Degrees of the Equator.

comes to pass, that as the whole Circle or all the 360 Degrees of the Equator answer to a whole *Nuchthemeron*, so a 24th Part or 15 Degrees of the Equator answer to a 24th Part of a *Nuchthemeron*, or such an Hour. And because these Hours are all thus usually measured by 15 Degrees of the Equator, hence they are all looked on as *Equal* one to another at all Times.

But the *Jews, Greeks, and Romans* did antiently divide (not the *Nuchthemeron* into 24 equal Hours, but) the Day, whether longer or shorter, into 12 Hours; and so likewise the Night. Whence it is obvious, that their Hours were *Unequal* one to another, except only at the two (\*) Equinoxes; when the Day and Night being Equal, their Hours would likewise be Equal, and so the same as to Extent with our Hours, though not as to Denomination.

---

(\*) Hence the equal Hours used by us are sometimes stiled *Equinoctial* Hours; and the unequal Hours used by the *Jews, &c.* are stiled *Temporary* Hours, from their varying in Length according to the other various Parts of the Year.



CHAP. For they always reckoning their first

I. Hour of the Day from the Sun's Rising,

which at the Equinoxes answers exactly  
9. to our six a Clock in the Morning, it

*How the  
unequal*

*Hours an-  
swer to our*

*common  
equal*

*Hours.*

*Which Ob-  
servation is*

*of use for*

*under-*

*standing*

*the Bible-*

*History.*

must answer at the Equinoxes to our seven a Clock in the Morning ; and consequently their third Hour to our nine a Clock in the Morning ; their sixth to our twelve a Clock at Noon ; their ninth to our three a Clock in the Afternoon, &c. And although there is not so exact a Correspondence between the Hours used by them and us, at other Times of the Year, yet the fore-mentioned Observation is of good Use for the better Understanding the several Hours of the Day mentioned in the Sacred History.

10.

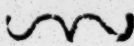
*As is also  
the Jewish  
Division of  
the Night  
into  
Watches,  
&c.*

Upon the like Account it is not to be here omitted, that the *Jews* divided the Night (not only into twelve Hours, as is afore observed ; but also) into four Quarters, called *Watches*, each Watch containing three of their Night-hours. These Watches were distinguished, either by their numeral Order, whence we expressly read in the Sacred History of the (\*) *Second*, *Third*, and (†) *Fourth*

(\*) *Luk. xii. 38.*

(†) *Matt. xiv. 25.*

Watch ;

Watch ; or by some other Denomina- CHAP.  
tion. Thus the first Watch is other- I.  
wise stiled the (\*) *Head or Beginning*   
*of the Watches* ; the Second, the (†)  
*Middle Watch*, because it lasted till  
Mid-night ; and the Fourth, the (‖)  
*Morning Watch*. Again, the First was  
termed (‡) the *Evening* ; the Second,  
*Mid-night* ; the Third, the *Cock-crow-*  
*ing* ; the Fourth, the *Dawning*.

The common Division of an Hour is I I.  
into *Quarters*. But Astronomers, and <sup>Of Mi-</sup>  
such as are more accurate in accounting <sup>utes, and</sup>  
Time, divide an Hour into sixty Parts, <sup>Seconds;</sup>  
called *Minutes* ; and a Minute again in- <sup>and the</sup>  
to sixty Parts, called *Seconds*, as being <sup>Difference</sup>  
Minutes of Minutes, and so secondary <sup>between</sup>  
Minutes. And here it is to be observed, <sup>Horary</sup>  
that the Word *Minute* is taken in a dou- <sup>and Gra-</sup>  
ble Sense, either to denote the sixtieth <sup>duary Mi-</sup>  
Part of an Hour, which therefore is <sup>utes.</sup>  
peculiarly stiled an *Horary Minute* ; or  
else to denote the sixtieth Part of a  
Degree, which therefore may be dis-  
tinguished by the Name of a *Graduary*  
*Minute*. And this *Graduary Minute* is

(\*) *Lam.* ii. 19.

(†) *Judg.* vii. 19.

(‖) *Exod.* xiv. 24.

(‡) *Mark* xiii. 35.

CHAP. subdivided by Astronomers into sixty

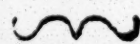
I. *Seconds*, and also each Second into sixty  
~~~~~ *Thirds*, and each Third into sixty  
Fourths, &c. whereas it is usual to sub-
divide an *Horary* Minute only into Se-
conds. Now as 15 Degrees of the E-
quator answer to one Hour or sixty *Ho-
rary* Minutes, so one Degree of the E-
quator, or sixty *Graduary* Minutes an-
swer to four *Horary* Minutes; and so one
Horary Minute to fifteen *Graduary* Mi-
nutes. And thus much for the several
Parts of Time, which arise from a Day
by Division, and Subdivision.



CHAP.

C H A P. II.

*Of the several Parts of Time, which
arise from a Day by Collection ;
viz. WEEKS, MONTHS, and
YEARS.*

AMONG the several Parts of C H A P.
Time, which arise from a Day I.
by Collection, it is proper to speak first 
of the *Week*, not only as denoting the I.
smallest Collection of Days, namely, *Of a Week
properly so
called.*
no more than seven ; but also as be-
ing the most Antient Collection, as
we learn from the Sacred History,
whereby we are taught that it was in-
stituted presently after the Creation,
and in Memory of God's creating the
World in six Days, *and resting on the
Seventh from all his Works, which he
had made.*

The seven Days of the Week are 2.
commonly distinguished by the Name *The seven
Days of
the Week,*
of the Planets, accounted also just
seven according to the Vulgar System, *whence
take their
common
Denomi-
nations.*
and placed in this Order from the
Highest to the Lowest, *viz. Saturn,*
M 3 *Jupiter,*

CHAP. *Jupiter, Mars, the Sun, Venus, Mer-*
 II. *cury, and the Moon.* Now the Astro-

logers supposing the fore-mentioned Planets to preside or rule over the several Hours of the *Nuchthemeron* according to their Order above-mentioned, hence denominate each Day of the Week from that Planet, which is supposed to preside over the first Hour of the *Nuchthemeron*. Whence it comes to pass, that the Days are denominated from the Planets according to the common Method. For assigning the first Hour of *Saturday* to *Saturn*, the second will fall to *Jupiter*, the third to *Mars*, the fourth to the *Sun*, the fifth to *Venus*, the sixth to *Mercury*, and the seventh to the *Moon*. And so the eighth Hour will fall to *Saturn* again, and also the fifteenth and twenty-second of the said *Nuchthemeron*; and consequently, the twenty-third Hour will fall to *Jupiter*, the twenty-fourth to *Mars*. By which means the first Hour of the next *Nuchthemeron* will fall to the *Sun*, and the first Hour of the next to the *Moon*, of the next to *Mars*, of the next to *Mercury*, of the next to *Jupiter*, of the next to *Venus*; and of the next to
Saturn

Saturn again, and so through the next CHAP. Week as afore. Hence the Days of II. the Week came to be distinguished in their Order by the *Latin* Names of *Dies, Saturni, Solis, Lunæ, Martis, Mercurii, Jovis, and Veneris*; and so among us by the Names of *Saturday, Sunday, Munday, Tuesday, Wednesday, Thursday, and Friday*. For as *Saturday, Sunday, and Munday*, plainly denote the Day of *Saturn*, the *Sun*, and the *Moon*; so *Tuesday, Wednesday, Thursday, and Friday*, denote the Day of *Tuisco, Woden, Thor, and Friga*; which are the *Saxon* Names respectively answering to *Mars, Mercury, Jupiter, and Venus*.

It is also not to be omitted, that, 3. because the *Easter* Week was formerly esteemed the First or Principal Week of the Year; and each Day thereof was a *Feria* or *Holy-Day*; hence the several Days of the Week were distinguished in their respective Order, among the Primitive Christians, by the Names of *feria Prima, Secunda, &c. i. e. the First, Second, (&c.) Holy-Day*: *Sunday*, or the *feria Prima* being otherwise stiled by them the *Lord's Day*,

The Days of the Week how denominated by the Antient Christians.

CHAP. *Day*, as being the Day of our Lord's
II. Resurrection.

~~~~~ Hitherto we have spoken of a Week  
4. in its common Acceptation, as it denotes  
*A Week sometimes taken to denote the Space of seven Years.* *a Week of Days, or seven Days.* But it is not wholly to be past by, that as the Original or *Hebrew* Word which we render a Week, does literally denote only in general a *Collection of Seven*, and therefore may be applied to Years as well as Days, (and the same holds as to the correspondent (\*) *Greek* and *Latin* Words,) so it is actually used in (†) some Places of the Sacred History to denote, not *seven Days*, but *seven Years*. And in Conformity to the Use of the said Original Word, our *English* Word *Week* is used in the said Places of Sacred Scripture to denote, not a *Week of Days*, but a *Week of Years*, or a Collection of seven Years.

5. Proceed we next to speak of *Months*,  
*A Synodical Month, primarily called a Month.* which, as they are of various Sorts, so are called by this one common Name, not by mere Chance, or without any Reason, but by Reason of

---

(\*) *Hebdomas and Septimana.*

(†) So Dan. ix. 24—27.

their all agreeing in some Relation to CHAP.  
 a Month primarily so called. Now II.  
 the (\*) *Hebrew* Word, to which our Word *Month* answers, does literally import the Time from one *New Moon* to another; and so does properly denote a *Synodical Month*. And forasmuch as this sort of Month is most distinguishable by our Sense, and so most obvious and proper to be used as a Measure of Time in the common Affairs of Life; hence it is more than probable, that, as our Word *Month* is evidently derived from the Word *Moon*, so it was primarily intended to denote likewise the Time from one *New Moon* to another, or a *Synodical Month*. For it is more than probable, that this Word in our Language (and so of the correspondent Words in all other Languages) was first used to denote that Sort of Month, which was first observed as a Measure of Time. But now it is not reasonably to be

---

(\*) The *Hebrew* Word *Chodesh* (is derived from a *Radix*, which signifies to *Renew*, and accordingly) does primarily denote the *New Moon*, or the *Day of the New Moon*; and thence it is secondarily taken to denote a *Month*, being the Space from one *New Moon* to another.

doubted,

CHAP. doubted, but the Synodical Month was

II. first used as a Measure of Time, forasmuch as it is obvious to the bare Sense, even of the Vulgar and most illiterate Persons.

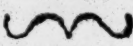
5. As for the *Periodical Month*, or the Time wherein the Moon goes round her *Orbit*, this could not be determined without some Observation and Study; and therefore no doubt was not taken Notice of, till sometime after the Synodical Month was used. And consequently it is not to be doubted, but the Name *Month* was applied to the Time of the Moon's Periodical Course, not primarily, but secondarily, or after it had for some Time been applied to the Moon's Synodical Course. And the Reason of imposing the same Name upon the Time of that, as had been imposed afore upon the Time of this, was, because both Times agree in the general, *viz.* as they relate to the Course of the Moon, and so may both from the *Moon* be called *Months*.

6. It has been afore (in the Astronomical Treatise, *Chap. 4. Sect. 2, 3.*) observed, that the Periodical Month consists of 27 Days and  $7\frac{3}{4}$  Hours; and the

of the different  
Lengths of  
the Syno-



the Synodical Month of 29 Days and CHAP.  
 $12 \frac{3}{4}$  Hours. And the Reason of this II.  
 Difference has been there accounted  
 for.

  
 dical and  
 Periodical  
 Month.

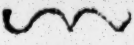
It is here to be further noted, that,  
 because during (either a Synodical or  
 Periodical) Month of the Moon, the  
 Sun passes well-nigh through a whole  
 Sign of the Ecliptick; hence the Time  
 of the Sun's passing quite through a  
 Sign is called a *Solar* Month, as nearly  
 answering to the Space of a *Lunar*  
 Month, especially the Synodical Month.  
 For as this Sort of *Lunar* Month is a  
 little above  $29 \frac{1}{2}$  Days, so the fore-men-  
 tioned *Solar* Month is almost  $30 \frac{1}{2}$  Days:  
 and consequently the Difference between  
 them is but about one Day.

7.  
 A Solar  
 Month,  
 what, and  
 why called  
 a Month.

But now because the fore-mentioned  
*Solar* and *Lunar* Months do not consist  
 just of whole Days, but of some odd  
 Hours and Minutes over, which cannot  
 be considered in the common Account  
 of Time; therefore some certain Num-  
 ber of just whole Days are made use of  
 instead of the fore-mentioned Astrono-  
 mical Months; but however are called  
 likewise *Months*, forasmuch as they  
 come as near as can be to the said *Astro-*  
*nomical* Months, from which they are

8.  
 Civil  
 Months,  
 what, and  
 why called  
 Months.

CHAP. distinguished by the Name of *Civil*

II. Months, as being adapted to Civil or  
 Common Use.

9.  
*A Month  
 of Weeks,  
 what.*

Thus in the first Place, what is most commonly called a Month among us, is made to consist just of twenty-eight whole Days, and so just of four whole Weeks; whence it is peculiarly stiled *a Month of Weeks*. It is obvious, that in Order to render the Computation of Time from Weeks to Months more easy, and so more fit for common Use, it was necessary that the Month should consist just of some certain Number of whole Weeks: which being thus necessary, four whole Weeks were made Choice of for the Number, which should constitute the Month; because this Number comes nearer than any other Number of Weeks, to the several Astronomical Months afore-mentioned.

10.  
*The Civil  
 Synodical  
 Month,  
 what.*

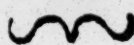
The Astronomical Synodical Month is adapted to Civil or Common Use, by making the Civil Synodical Month to consist alternately of (\*) twenty-

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(\*) A Civil Synodical Month consisting of thirty Days, is called *Plenus*, i. e. a Full Month; and a Civil Synodical Month consisting but of twenty-nine Days, is called *Cavus*, i. e. an *Hollow* or *Defective* Month.

nine and thirty whole Days; for 29 CHAP.

$+ 30 = 59 = 29\frac{1}{2} \times 2$ , that is, two II.

Civil Synodical Months are equal to  two Astronomical Synodical Months, omitting in both the odd Minutes. And consequently, according to this Method, the New Moon will keep to the first Day of every such Civil Month for a long time together, when once adjusted thereto. This was the Month in Civil or Common Use among the *Jews*, *Greeks*, and *Romans*, till the Time of *Julius Cæsar*, and is still so among the *Turks*.

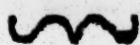
In like manner, the Astronomical So- II.  
lar Month may be adapted to common *The Solar Months might be uniformly adapted to Civil or Common Use.*  
Use, by making the Civil Solar Months to consist alternately of thirty and thirty-one Days, excepting one Month of the twelve, which should consist of thirty Days every four Years; the other three Years it must consist only of twenty-nine Days. This is illustrated by the adjoining Scheme or Table of the Solar Months.

Months.



## CHAP.

## II.



| Months.      | Days. | Months.          | Days. | Months.         | Days. |
|--------------|-------|------------------|-------|-----------------|-------|
| <i>March</i> | 31    | <i>Quintilis</i> | 31    | <i>November</i> | 31    |
| <i>April</i> | 30    | <i>Sextilis</i>  | 30    | <i>December</i> | 30    |
| <i>May</i>   | 31    | <i>September</i> | 31    | <i>January</i>  | 31    |
| <i>June</i>  | 30    | <i>October</i>   | 30    | <i>February</i> | 29    |

And every fourth Year, 30

For according to this regular and uniform Method, there will be 365 Days in the twelve Solar Months for three Years together, and every fourth Year 366 Days, just as it is now.

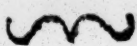
12.  
*The Solar  
Months  
how came  
to be instituted,  
as  
in Use among  
us.*

It is evident then, that the Civil Solar Months might be thus uniformly constituted. And indeed they were so constituted in the main at first by *Julius Cæsar*, who brought the Solar Months into common Use among the *Romans*, whereas they used afore the Civil Lunar Month, as was (\*) observed when we were speaking of the said Lunar Month. The Alteration was made afterwards, when (as the fifth Month, which had afore been called from its Rank, *Quintilis*, was new named *Julius* in Honour of the Emperor of that Name; so ) the sixth Month, which had afore been called

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(\*) Sect. 10th of this Chapter.

from

from its Rank, *Sextilis*, was new CHAP.  
named *Augustus* in Memory likewise of II.  
the Emperor of the same Name; and   
not only so, but (whereas this Month  
consisted afore but of thirty Days,  
and so was a Day shorter than the  
foregoing Month of *July*,) there was  
a Day more added to it, that so the  
Honour paid to *Augustus* might not  
seem to fall short of the Honour paid  
to *Julius*, even in this Punctilio. Now  
this Alteration being made as to the  
Month of *August*, it (according to the  
alternate Method at first instituted, and  
still preserved in the following Months)  
made an Alteration in all the follow-  
ing Months, except *January*, which  
upon this Alteration should have had  
but thirty Days according to the alter-  
nate Method primarily instituted. But  
this Month being so named in Honour  
of *Janus*, esteemed by the *Romans*, the  
God of Time, on the like Considerati-  
on that it seem'd proper to lengthen the  
Month of *August* by a Day, it might  
seem not proper to lessen the Month of  
*January* by a Day, but rather to con-  
tinue it still thirty-one Days long, and  
to make *February*, which afore was  
twenty-

CHAP. twenty-nine, and every fourth Year

II. thirty Days long, to be commonly but  
 twenty-eight, and every fourth Year  
 but twenty-nine Days long. And so  
 the Solar Months came to stand, as  
 they do now now in our *Calendar*,  
 (whence they are called the *Calendar*  
*Months*) in reference to the Names and  
 Number of Days assigned to each, set  
 down in short in the following Ta-  
 ble.

| Months.      | Days. | Months.          | Days. | Months.         | Days. |
|--------------|-------|------------------|-------|-----------------|-------|
| <i>March</i> | 31    | <i>July</i>      | 31    | <i>November</i> | 30    |
| <i>April</i> | 30    | <i>August</i>    | 31    | <i>December</i> | 31    |
| <i>May</i>   | 31    | <i>September</i> | 30    | <i>January</i>  | 31    |
| <i>June</i>  | 30    | <i>October</i>   | 31    | <i>February</i> | 28    |

But every fourth Year, 29

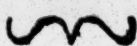
By comparing this and the forego-  
 ing Table, will be illustrated what-  
 ever has been here said, either con-  
 cerning the first Institution of the So-  
 lar Months among the *Romans* by *Ju-  
 lius Cæsar*; or concerning the Changes  
 that have been since introduced. And  
 also it will appear, that the whole  
 Number of Days, contained in the  
 twelve Solar Months taken together,  
 hath been all along the same, viz.  
 365 Days, and every fourth Year 366  
 Days. The former of which Sums is



the Time, wherein the Sun seems to pass through the twelve Signs, (\*) omitting the odd Hours and Minutes, and the latter Sum is the Time, wherein the Sun seems to pass through the twelve Signs, adding thereto the odd Hours and Minutes which were omitted the three foregoing Years, and so many Minutes more as make the said odd Hours and Minutes equal to a whole Day in four Years.

Now as these twelve Solar or Calendar Months make up the Civil Solar Year in use among us (in which Sense it is, that a *Twelve-Month* is used by us as an Equivalent Term to a Year) so what has been said concerning the Sums of 365 and 366 Days being contained in the twelve Calendar Months taken together, will be more particularly explained, when we come presently to speak of the Civil Year in use among us; after that we have made some short Observations concerning the Year in general.

CHAP.  
II.



13.  
A Twelve-Month,  
how Equivalent to a Year.

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(\*) See Sect. 16, of this Chapter.

N

By

CHAP. By a (\*) *Year* then (the only Part II. of Time remaining to be treated of)

is denoted in general a Revolution of

14. a Celestial Light round the Heavens by

A Year,  
what, in  
general.

It is pro-  
perly taken  
to denote a  
Solar Year.

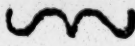
(what is esteemed) its proper Motion. Thus an entire (apparent) Revolution of the fixed Stars is stiled the *Great Year*; and the Time wherein *Saturn*, *Jupiter*, and *Mars*, go round their *Orbits*, is respectively stiled the Year of *Saturn*, *Jupiter*, and *Mars*; and accordingly the Time of the Moon's going round her *Orbit*, commonly called her Periodical Month, is sometime stiled her Year. But by a Year is principally and properly denoted the Time, wherein the Sun appears to move round the Ecliptick, which is 365 Days, 5 Hours, and very near  $49\frac{1}{2}$  Minutes.

15. Now because during the Time of one *Solar Year*, there are twelve Synodical Months; hence twelve Syno-

A Lunar  
Year, what

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(\*) As the *Latin* Word *Annus* primarily denotes a Circle (whence *Annulus* signifies a Ring) and is thence taken to denote a Year, as being a Circle of Time, which being once gone round is begun again; so the *Greek* Word *ἐνιαυτός*, and the *Hebrew* Word *Shanah* is of the like Importance.

dical Months constitute (what is called CHAP. II.  
 a *Lunar Year*;) which therefore consists  
 of 354 Days, 8 Hours, and a little more   
 than 48 Minutes. So that the exact  
 Difference between the Astronomical  
 Solar and Lunar Year is 10 Days, 21  
 Hours, and 1 Minute.

But whereas the Hours and Minutes 16.  
 above the whole Days of a Solar Year, *The Astro-*  
 can't be taken Notice of in Civil or *nomical*  
 Common Use; therefore the Civil So- *Solar Year,*  
 lar Year in use among us, is made to *how adap-*  
 consist only of 365 Days for three Years *ted to Civil*  
 together, and every fourth Year of 366 *or Common*  
 Days. Namely, whereas in an Astro- *Use.*  
 nomical Solar Year there are, above the  
 whole Days, 5 Hours, and very near  
 49  $\frac{1}{2}$  Minutes; there are added every  
 Year about 11 Minutes, to make up  
 this just six Hours; and these six Hours  
 amount just to a whole Day in four  
 Years.

Each of the three Years consisting 17.  
 only of 365 Days, is called a *Common* *A Bissex-*  
 Year; and every fourth Year consisting *tile or*  
 of 366 Days, is called a *Bissextile* or *Leap-*  
*Year*. The Reason of its being *Year, why*  
 called *Bissextile* is, because the Day a- *so called,*  
 rising in four Years out of the six Hours



CHAP. afore-mentioned, is this Year *intercalated*, i. e. inserted into the Calendar, by reckoning (according to the Roman Way, *bis sextum Kal. Martii*, i. e. by reckoning) *twice the sixth Day* before the Calends of *March*, which answers to our twenty-fourth of *February*. But although we took our Civil Solar Year from the *Romans*, yet we do not imitate them in this particular, but instead of reckoning *February* the twenty-fourth twice, we reckon this Year twenty-nine Days in *February*, whereas in common Years we reckon but twenty-eight. But although we reckon not *February* twenty-fourth twice, yet we reckon twice the Calendar Letter always belonging to *February* the twenty-fourth; namely *f*. And by this means, that which was the *Sunday Letter* from *January* the first to *February* twenty-fourth, will be so no longer, but the Letter next before it in the Order of the Alphabet, will be the *Sunday Letter* for the remaining Part of the Year. From which *Leap* or Change from one *Sunday Letter* to another, this Year came to have the Name of *Leap-Year* amongst us.

It

It has been afore observed, that the CHAP. Astronomical or true Solar Year does II. consist of 365 Days, 5 Hours, 49  $\frac{1}{2}$  Mi- minutes. Whereas to adapt it to Civil 18.

Use, the Solar Year is conceived to con- *The Civil Solar Year too long by eleven Minutes; and of the Gregorian Reformation of the Calendar caused thereby.* sist of 365 Days, and just six Hours; (which six Hours in four Years make up just another whole Day;) so that the Civil Solar Year is about eleven Minutes longer than the true Solar Year. Hence it comes to pass, that the Seasons, or (which comes to the same) the Equinoxes and Solstices, depending on the true Solar Year, do not keep always to the same Time or Part of our Civil or Common Year, but vary every Year about eleven Minutes, (*viz.* 10', and 48'') and consequently about a whole Day in 133 Years. Wherefore from A. D. 325, when the famous *Nicene Council* was held, to A. D. 1582, wherein Pope Gregory the XIIIth reformed the Calendar, there was found to have arose a Variation of ten Days; the Vernal Equinox, which at the Time of the *Nicene Council* fell about the 21st of *March*, in A. D. 1582, being found to fall on *March* the 11th. Hereupon the fore-mentioned Pope,

CHAP. intending to bring back the Equinox to  
 II. the Time of the Year it fell upon at  
 the *Nicene Council*, ordered *October 5th*,  
 (in the Year 1582.) to be reckoned  
*October 15th*, thereby suppressing ten  
 Days, and making the following *March*  
*11th* to be reckoned *March 21st*; and  
 so the Vernal Equinox, which other-  
 wise would have been reckoned to fall  
 on *March 11th*, to fall on *March*  
*21st*, as at the Time of the *Nicene*  
*Council*. And that the like Variation  
 might not happen again, the said *Pope*  
 ordered, that once in 133 Years a Day  
 should be taken out of the Calendar;  
 or (which comes to the same) that three  
 Days should be taken out every four  
 Hundred Years, after this Method, *viz.*  
 whereas, according to the Account a-  
 fore (and still by us) used, every Hun-  
 dredth Year from the Nativity of our  
 Saviour is a *Leap-Year*; from thence-  
 forth only every *four* Hundredth Year  
 should be a *Leap-Year*; and the other  
 Hundred Years should be common  
 Years.

19.  
 Old-Style  
 and New  
 Style,  
 what.

As the Account afore in use, is  
 thence called the *Old Style*; as also the  
*Julian Account* or *Julian Year*, from  
*Julius Cæsar*, by whose Authority it  
 was



was first introduced among the *Romans*, CHAP. II.  
 forty-six Years before Christ, according to the Common Account by the Years of our Lord: So this Form of the Civil Solar Year introduced by the fore-mentioned Pope *Gregory*, is from him called the *Gregorian Account*; as also from its being (comparatively with the former) newly introduced, the *New-Style*. And this is used in *Italy, France, Spain*, and where-ever the *Pope's* Authority is acknowledged; and as it had been received from the first by the *Popish* Countries of *Germany*, so towards the End of the last Century it was received also by many of the *Reformed* People of *Germany*, as to their Civil or Common Account of Time. For as to their Ecclesiastical Account, or finding the (*Eastern Moon*, or) Time of *Easter*, these do or did till (\*) very lately follow the *Rudolphine Tables* of *Kepler*. The *Old-Style* is still used by *Us* of this Island, as also in *Ireland*, and by some others.

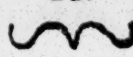
Although the Calends or First of *January* is now-adays, almost through- 20.

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(\*) The Publick News-Papers have in general given Account of some Reformation or Alteration made lately in this Respect by the Protestants in *Germany*. Of the various Beginnings of the Civil Solar Year in various Countries.

CHAP. out all *Europe*, commonly looked on as  
 II. the Beginning of the Year, whether  
 ~~~~~ *Julian* or *Gregorian*; yet there are  
 some, who reckon the Beginning of
 it from some other Part of the Year.
 Thus the *Venetians*, *Florentines*, and
Pisans in *Italy*, and the Inhabitants of
Triers or *Treves* in *Germany*, reckon
 the Beginning of the Year from the
 Vernal Equinox. The Church of *Eng-*
land, in Conformity to the Antient U-
 sage of the Christian Church, reckons
 her Ecclesiastical Year from the Feast
 of the Annunciation, commonly called
 by us *Lady-Day*. And our Civil Year,
 according to our Law, takes also its
 Beginning from the same Day; though
 the common People, and others among
 us in Matters not requiring the Nicety
 of a Legal Date, reckon the Begin-
 ning of our Year from the first of *Ja-*
nuary.

21. It has been afore observed, that the
 The Astro- Lunar Year, how adapted to Civil Use; and first of the Wan-
 nomical dring Lu-
 Lunar Year. Lunar Year, strictly or according to Af-
 tronomical exactness, consists of 354
 Days, 8 Hours, and a little more than
 48 Minutes. But to adapt this also to
 Civil Use, the Civil Lunar Year is ef-
 teemed to consist only of 354 whole
 Days.

Days. So that the Difference between CHAP. the Civil Lunar Year of 354 Days, and II. the Civil Solar Year of 365 Days, is  eleven Days; the former being so much shorter than the latter. Hence it comes to pass, that such as use the Civil Lunar Year, without any regard to the aforesaid Difference, their Year, supposing it to begin now in Spring, will after eight Years Time begin in Winter; and after eight Years more in Autumn, and so after that in Summer; and lastly, after about thirty three Years in all, will begin in Spring again. Hence it is called *Annus Lunaris Vagus*, or the *Wandering Lunar Year*; because its Beginning thus *wanders* through the several Seasons, and that in the Memory of Man. And this is the Sort of Year used by the *Turks*.

Others, though they used or use 22. the Civil Lunar Year, yet remedy the fore-mentioned Inconveniency of its Of the fixed Lu- thus changing the Time of its Begin- nar, or ning, by having Regard to the fore- Luna So- mentioned Difference of eleven Days, lar Year.

between the Civil Solar and Lunar Year; namely, by intercalating so many Months, as the said Difference

CHAP. of eleven Days arise to in such a number of Years. By which means the Lunar and Solar Year are kept so adjusted one to the other, as that the Beginning of the Lunar Year will keep in a manner fixed to the same Part of the Solar Year. Hence this Sort of Year is called the *fixed* Lunar Year; as also the *Luni-Solar* Year; and it is used by the *Jews*, and the Church of *Rome* in her Ecclesiastical Account. And thus much for the several *Parts*, into which Time in general is distinguished.



CHAP.

C H A P. III.

*Of the several CHARACTERS of Time
in general : and particularly of
the CYCLE of the MOON, and the
E P A C T S.*

PROCEED we now to speak of the se- C H A P.
veral *Characters*, whereby particu- III.
lar Times are distinguished one from the other. And these are either *Natural* I.
or *Instituted* by Men.

The Natural Characters of Time are such as depend on Natural Causes, and are these ; viz. *New Moons, Full Moons, Eclipses*, either of the Sun (as they are commonly call'd) or Moon, the two *Equinoxes*, the two *Solstices*, the *Cycle of the Moon*, and the *Epaets* of the Moon. All which have been sufficiently spoken of in the foregoing Treatise of Astronomy, except the *Cycle* and *Epaets* of the Moon ; which are therefore to be here explained.

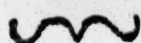
The Characters of Time two-fold.

2.

The Natural Characters of Time, what.

The

CHAP. The Cycle of the Moon then is to be
 III. esteem'd a (*) Natural Character of



Time, because it depends on a Natural
 3. Cause, viz. the Motion of the Moon :
 of the Cy- which is such, that, after nineteen Years
 cle of the very nearly, the New Moons and Full
 Moon. Moons are observed to fall on the

same *Nuchtbemeron* of the *Julian* Year,
 as they did nineteen Years afore. Hence
 this Cycle is otherwise termed the Cy-
 cle of nineteen Years.

4.
 of the
 Golden
 Number,
 or Prime.

The New Moons being observed to
 fall out thus, they were wont former-
 ly to calculate or find out the Time of
 the New Moons (without the Help of
 Astronomical Tables) after this man-
 ner. They observed, on what Day
 of each Calendar Month the New
 Moon fell, in each Year of this Cycle ;
 and to the said Days they set respec-
 tively the Number of the said Year.
 Thus observing, that the New Moons,
 in the first Year of this Cycle, fell on
January 23d, February, 21st, March 23d,

(*) Some esteem this, not a *Natural*, but an *Instituted* Character of Time. But not so properly, since it depends on a *Natural* Cause.

&c. they set the Number 1 to the said CHAP. Days. And in the like manner, obser- III.
ving that, in the second Year of this Cycle, the New Moons fell on *January 12th, February 10th, March 12th,* &c. to the said Days they set the Number 2. And after this Method they went through all the nineteen Years of this Cycle; as may be seen (*) in the Calendar adjoining to the End of this Chronological Treatise. The Numbers thus set to the Days whereon the New Moons fell in each Year, are called the *Golden Numbers*, either because they were formerly wont to be writ in Gold, or else because of their Golden or great Use. Any one of these Golden Numbers is otherwise called the (†) *Prime*, because the said Numbers were placed in the Prime or First Column of the Calendar, as they still are in our Church Calendar, and in the Calendar adjoining to this Treatise: Or else

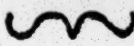
(*) As also in the Calendar of the Common Prayer-Book.

(†) It is called by this Name in the Directions belonging to the *Table for finding Easter for ever* in the Common-Prayer-Book.

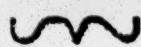
because

34 *Of the CYCLE of the MOON.*

CHAP. because each Golden Number denotes

III. *Luna Prima*, or the first Day of the
 New Moon, according to which way
of speaking the Full Moon is frequently styl'd *Luna Quartadecima*, as falling on the Fourteenth Day after the New Moon inclusively. The Golden Numbers being thus placed, it was easy to find, what Day of any Month in any Year given the New Moon will fall upon, it being known to what Year of the Moon's Cycle the Year given answered. Thus suppose, A. D. 354, to be the Year, given, which answers to the 13th Year of the Moon's Cycle; and suppose it be enquired, what day of *March* the New Moon fell upon that Year, I look for the Number 13 in the Month of *March*, and find it set to the 11th Day; whereby is shewn, that the New Moon fell that Year on that Day of *March*.

5. And by this Method the New
How to find Moon could be found with Accura-
the New cy enough at the Time of the *Nicene*
Moons at Council, forasmuch as the Golden Num-
present by ber did then shew the Day (*i. e.* the
the Golden *Nuchthemeron*) within which the New
Number. Moon fell out. And hereupon is found-

ed the Rule of the Nicene Council for CHAP.
 finding *Easter*, of which more in Chap- III.
 ter 7th. It is here to be observed, that 
 the Golden Numbers do not now shew
 the Days, whereon the New Moons
 fall. For the Cycle of the Moon is
 less than nineteen *Julian* Years, by 1
 Hour, 27 Minutes, and almost 32 Se-
 conds. Whence it comes to pass, that,
 although the New Moons fall again
 upon the same *Days*, as they did
 nineteen Years afore, yet they fall not
 on the same *Hour* of the Day or *Nuch-*
themeron ; but 1 Hour, 27 Minutes,
 and almost 32" Sooner. And this Dif-
 ference arising in about 312 years to
 a whole Day, hence the New Moons
 after every 312 years fall a whole Day
 (*i. e.* *Nuchthemeron*) sooner. Upon this
 Score the New Moons fall now four
 Days sooner, than they did at the Time
 of the *Nicene Council*. Which being
 observed, the Day (*i. e.* the *Nuchthe-*
meron, though not the Hour of it) on
 which the New Moons fall, may be
 now found by the Golden Number.
 For Instance, I would know on what
 Day of *January* the New Moon will
 fall next Year, *viz.* 1712. This, by
 the

CHAP. the Rule delivered in the following
 III. Paragraph, will be found to be the
 ~~~~~ third year of the Moon's Cycle. I look  
 therefore for the Golden Number 3, and  
 find it (in the Calendar) placed to  
*January* the 1<sup>st</sup>, and again to *January*  
 the 31<sup>st</sup>, so that about the Time of the  
*Nicene Council*, there were two New  
 Moons in the Month of *January*, every  
 third year of the Moon's Cycle. Where-  
 as, according to the fore-mentioned  
 Observations, each of the said two New  
 Moons falling now four Days sooner,  
 the first of them falls upon *December*  
*28th* of this present Year, 1711; and  
 only the other falls in the *January*  
 following, viz. on *January 27th*,  
 1712.

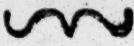
6. It remains now to shew, how it is  
 to be found, what Year of the Moon's  
 Cycle any given Year of Christ an-  
 swers to. And this is done by (\*)  
 adding 1 to the given Year of Christ,  
 and then dividing the Sum by 19. If  
 19 just divides the Number of the  
 Year given, then it is the 19<sup>th</sup> or  
 last Year of the Moon's Cycle; If 19

To find  
 what Year  
 of the  
 Moon's  
 Cycle any  
 given Year  
 of Christ  
 answers to.

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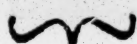
(\*) The Reason of adding 1 is, because the *Æra* of  
 Christ began in the second Year of this Cycle.

does

does not just divide the said Number, CHAP. III.  
 but somewhat of the said Number re-  
 mains over, then the said Remainder   
 shews the Year of the Moon's Cycle.  
 For instance, I would know to what  
 Year of the Moon's Cycle A. D. 1712  
 answers. And by this Rule I find it to  
 answer to the third Year of the Cycle ;  
 for  $1712 \div 19$  being divided by 19, there  
 will remain 3. And thus much for the  
 Cycle of the Moon.

Come we next to the Epacts of the Moon. 7.  
 It has been afore observed, that *Of the Epacts of the Moon,*  
 the Civil Lunar Year is eleven Days  
 shorter than the Civil Solar Year. Con-  
 sequently, two such Lunar Years will  
 be twenty two Days shorter than two  
 such Solar Years ; and three Lunar Years  
 will be shorter than three Solar Years by  
 thirty-three Days. Now such as use  
 the fixed Lunar (otherwise called the  
 Luni-Solar Year, in order to adjust the  
 said Lunar Year to the Solar, as often as  
 the Lunar Year does thus come to be  
 thirty three Days shorter than the Solar,  
 do intercalate a Month of thirty Days  
 into the Lunar Year ; except only  
 every 19th Year, viz. the last Year of  
 the Moon's Cycle) when the interca-  
 O lated

CHAP. lated Month consists but of twenty-nine  
III. Days.

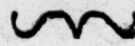


| Golden Number. | Epacts.  |
|----------------|----------|
| 1 . . .        | . XI.    |
| 2 . . .        | ..XXII.  |
| 3 . . .        | ...III.  |
| 4 . . .        | ..XIV.   |
| 5 . . . .      | ..XXIV.  |
| 6 . . . .      | ..VI.    |
| 7 . . . .      | ..XVII.  |
| 8 . . . .      | ..XVIII. |
| 9 . . .        | ..IX.    |
| 10 . . .       | . XX.    |
| 11 . . .       | ..I.     |
| 12 . . .       | ..XII.   |
| 13 . . .       | ..XXIII. |
| 14 . . .       | . IV.    |
| 15 . . .       | . XV.    |
| 16 . . .       | ..XXVI.  |
| 17 . . .       | ..VII.   |
| 18 . . .       | ..XVIII. |
| 19 . . .       | XXIX.    |

By this means the Civil Lunar and Solar Years are kept so adjusted together, as that the first Year of the MOON's Cycle comes not shorter of the Solar Year than eleven Days; the second Year of the said Cycle not shorter than 22 Days; the third Year shorter only

by three Days, &c. as may be seen in the adjoining Table. Namely, as the New Moons are the same (*i. e.* fall on the same Day) every nineteen Years, so the difference between the Lunar and Solar Year is the same every nineteen Years. And because the said Difference is always to be added to the Lunar Year, in order to adjust or make it equal to the Solar Year; hence the said Difference respectively belonging to each Year



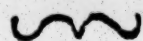
Year of the Moon's Cycle, is called the CHAP.  
*Epact* of the said Year, *i. e.* the Num- III.  
 ber to be *added* to the said Year to make   
 it equal to the Solar Year.

Upon this mutual Respect between the 8.  
 Cycle of the Moon, and the Cycle of How to  
 the Epacts, there is founded this Rule find the  
 for (\*) finding the Epact belonging to Epacts of  
 any Year of the Moon's Cycle. Multi- the Moon  
 ply the Year given of the Moon's Cycle according  
 into 11; if the Product be less than 30, to the Ju-  
 it is the Epact sought; if the Product lian Ac-  
 be greater than 30, divide it by 30; and count.  
 the Remainder of the Dividend is the  
 Epact, *Ex. gr.* I would know the E-  
 pact for A. D. 1712, which has been al-  
 ready found to be the third Year of the  
 Moon's Cycle. Wherefore three is the E-  
 pact for A. D. 1712: for  $11 \times 3 = 33$ ,  
 and 33 being divided by 30, there is  
 left three of the Dividend for the Epact.

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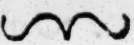
(\*) Namely in respect of the *Julian* Account. For in  
 respect of the *Gregorian* Account there is a different Me-  
 thod, the Epact being different. However, the *Julian*  
*Epact* being known, it is easy thence to know the *Gre-*  
*gorian Epact*. Namely, if the *Julian* Epact be greater than  
 11, Subtract 11 from it: if less, add 30 to it, and out  
 of the Sum Subtract 11, and the Residue will be the *Gre-*  
*gorian Epact*. For instance; it has been found, that Three  
 is the *Julian* Epact for A. D. 1712. Wherefore  $3 +$   
 $30 = 33$ , and  $33 - 11 = 22$ . which last Number (*viz.*  
 22.) is the *Gregorian Epact* for the said Year, 1712.

CHAP. By the Help of the Epact may be  
 III. found, what Day of any Month in any



Year the New Moon falls on, thus: To  
 9. the Number of the Month from *March*  
 To find by the Epacts, what Day of any Month in any Year the New Moon falls on. inclusively, add the Epact of the Year given; if the Sum be less than 30, Subtract it out of 30; if greater, Subtract it out of 60; and the Remainder will be the Day, whereon the New Moon will fall. *N. B.* If the New Moon be sought for the Month of *January* or *March*, then nothing is to be added to the Epact; if for *February* or *April*, then only 1 is to be added. *Ex. gr.* I would know what Day of *December* the New Moon will fall on this A. D. 1711, the Epact whereof is 22. By the aforesaid Rule, I find it will be *December 28th*, for  $22 + 10 = 32$ , and  $60 - 32 = 28$ .

10. The Day, whereon the New Moon  
 To find the Age of the Moon. falls, being thus found, it is easy from thence to infer, what the *Age of the Moon* is on any Day given. However, there is a peculiar Rule commonly made use of to this purpose, which is this: Add the Epact of the Year, the Number of the Month from *March* inclusively, and the given Day of the Month all into one Sum: which, if it be less than

than 30, shews the Age of the Moon; CHAP. if it be greater than 30, divide it by 30, III. and the Remainder of the Dividend  shews the Age of the Moon, or how many Days it is from the last New Moon. And this Method will never err a whole Day. For instance, I would know, what will be the Age of the Moon on *December 31<sup>st</sup>* of this Year 1711. By this Rule I find, that the Moon will then be three Days Old, *i. e.* that it will then be three Days from the last New Moon. For  $22 + 10 + 31 = 63$ , and 63 being divided by 30, there will remain of the Dividend 3. And this exactly agrees to the other foregoing Rule, whereby it was found, that the New Moon will fall on *December 28<sup>th</sup>* of this Year 1711.

It remains only to observe, that the Epacts of the Moon are justly to be esteemed as (\*) Natural Characters of Time; forasmuch as they depend on a Natural Cause, *viz.* the Motion of the Moon. For the Reason, why the Civil

II.

*The Epacts  
of the Moon  
are to be  
esteemed  
Natural  
Characters.*

---

(\*) This is insisted upon, because the Epacts are by some esteemed, not *Natural*, but *instituted* Characters.



CHAP. Lunar Year is less than the Civil Solar  
III. (i. e. *Julian*) Year by eleven Days, is,  
because as the Moon goes round her  
*Orbit*, there are twelve Conjunctions of  
her and the Sun, (or twelve Synodical  
Months, which make up a Lunar Year)  
in less Time by eleven Days very nearly,  
than the Sun seems to go once round  
the *Ecliptick*. And in like manner, the  
Reason why the Cycle of the Epacts, as  
well as that of the Moon, consists of  
nineteen Years, is, because in that Inter-  
val of Time, the Moon's Motion has  
(much) the same Respect to the Sun, as  
it had nineteen Years afore. And thus  
much for the *Natural* Characters of  
Time.



## C H A P. IV.

*Of the Cycle of the SUNDAY-LETTER,  
commonly called the Cycle of the  
SUN.*

**T**HE *Cycle of the Sun* is very im-  
properly so called, forasmuch as  
it relates not to the Course of the Sun,  
but to the Course of the Dominical  
or *Sunday-Letter*; whence it ought to  
be called the *Cycle of the Sunday-Letter*.  
It consists of twenty-eight Years, for-  
asmuch as after every twenty-eight  
Years the Course or Order of the  
*Sunday-Letter* is the same, as it was  
afore.

C H A P.  
IV.

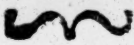
1.  
*The Cycle  
of the Sun  
improper-  
ly so called.*

The Use of this Cycle arises from  
(\*) the Custom of Assigning in the  
Calendar to each Day of the Week,  
one of the first seven Letters of the  
Alphabet; *A* being always affixed to

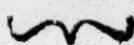
2.  
*of the Use  
of this Cy-  
cle.*

---

(\*) This Custom being Arbitrary, hence this Cycle  
not a Natural Character, but of Humane Institution.

CHAP. *January 1st*, whatever Day of the  
 VI. Week it be; *B* to *January 2d*, *C* to  
 *January 3d*; and so in order *G* to  
*January 7th*. After which the same  
 Letters are repeated again, *A* being  
 affixed to *January 8th*, &c. According  
 to this Method, there being 52 Weeks,  
 in a Year, the said seven Letters are re-  
 peated 52 Times in the Calendar. And  
 were there but just 52 Weeks, the Let-  
 ter *G* would belong to the last Day of  
 the Year, as the Letter *A* does to the  
 first; and consequently, that Letter,  
 which was at first constituted the *Sun-*  
*day-Letter*, (and the same is to be un-  
 derstood of the other Days of the Week)  
 would always have been so; and there  
 would have been no Change of the  
*Sunday-Letter*. But our Year consisting  
 of 52 Weeks, and an odd Day over,  
 hence it comes to pass, that the Letter  
*A* belongs to the last, as well as to the  
 first Day of every Year. For, although  
 every Leap-Year consists of 366 Days,  
 and so of two Days over 52 Weeks,  
 yet it is not usual to add a Letter more,  
*viz. B*, to the End of the Year; but in-  
 stead thereof to repeat the Letter *F*,  
 which

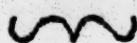


which (\*) answers to the 24<sup>th</sup> of *Fe-CHAP.*  
*bruary*, and to affix it again to the in- IV.  
 tercalated Day (as has been (†) afore   
 observed) which we call *February 25<sup>th</sup>*.  
 By which means the said seven Letters  
 of the Alphabet remain affixed to the  
 same Days of a Leap-Year, as of a  
 Common Year, through all the rest of  
 the Calendar, both before and after.  
 The Letter *A* then thus always belong-  
 ing to the first and last Day of the same  
 Year, and consequently to the last Day  
 of the Old Year, and first Day of the  
 New; it thence comes to pass, that  
 there is a Change made as to the *Sun-*  
*day-Letter* in a backward Order, that  
 is, supposing *G* to be the *Sunday-Let-*  
*ter* one Year, *F* will be the next, and  
 so on: which is illustrated by the fol-  
 lowing Table; where it must be obser-  
 ved, that the great Letter is the *Sunday-*  
*Letter* for each Year.

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(\*) As may be seen in the Calendar adjoined to the  
 End of this Treatise.

(†) Chap. 2. §. 17.

CHAP.  
IV.

December 1711.

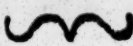
|            |           |
|------------|-----------|
| a . . . 24 | Monday    |
| b . . . 25 | Tuesday   |
| c . . . 26 | Wednesday |
| d . . . 27 | Thursday  |
| e . . . 28 | Friday    |
| f . . . 29 | Saturday  |
| G . . . 30 | Sunday    |
| a . . . 31 | Monday    |

January 1712.

|           |           |
|-----------|-----------|
| a . . . 1 | Tuesday   |
| b . . . 2 | Wednesday |
| c . . . 3 | Thursday  |
| d . . . 4 | Friday    |
| e . . . 5 | Saturday  |
| F . . . 6 | Sunday    |
| g . . . 7 | Monday    |
| a . . . 8 | Tuesday   |

3.  
The Odd  
Day in  
every Com-  
mon Year  
makes a  
single  
Change in  
the Sun-  
day-Let-  
ter.

As from the foregoing Table it is evident, how the odd Day above 52 Weeks in a Year does make the *Sunday-Letter* change from one Letter to the next to it in a backward Order ; so it is obvious, that were there but this single Change, *Sunday* would be denoted by each of the seven Letters every seven Years, and so the Cycle of the *Sunday-Letter* would consist of no more than seven Years. But now there being in every fourth or Leap-Year two Days above 52 Weeks, hence it comes to pass, that there is every such Year a double Change made as to the *Sunday-Letter*. Namely, as the odd single Day above 52 Weeks in a common Year, makes (as has been shewn by the foregoing Table ) the first *Sunday* in *January* to shift from that which was the *Sunday-Letter* of the foregoing Year, to the next Letter

Letter to it in a backward Order ; so CHAP.  
 the other Day, intercalated every Leap- IV.  
 Year after the 23<sup>d</sup> of *February*, (tho' )  
 it makes no change as to the Days of  
 the *Month*, to which the Alphabetical  
 Letters respectively belong ; which is  
 brought about by the Artifice of repeat-  
 ing the Letter *F* twice, as was before  
 observed : yet it ) does make a Change  
 as to the Days of the *Week*, to which  
 each Alphabetical Letter is to belong  
 for the remaining Part of the Year ; as  
 is evident by the following Table con-  
 taining the latter Part of *February* 1712,  
 being Leap-Year, and the former Part  
 of *March*.

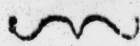
| February. |   |                  | March. |   |                  |
|-----------|---|------------------|--------|---|------------------|
| 23        |   | <i>Saturday</i>  | 1      | d | <i>Saturday</i>  |
| 24        | F | <i>Sunday</i>    | 2      | E | <i>Sunday</i>    |
| 25        | f | <i>Monday</i>    | 3      | f | <i>Monday</i>    |
| 26        | g | <i>Tuesday</i>   | 4      | g | <i>Tuesday</i>   |
| 27        | a | <i>Wednesday</i> | 5      | a | <i>Wednesday</i> |
| 28        | b | <i>Thursday</i>  | 6      | b | <i>Thursday</i>  |
| 29        | c | <i>Friday</i>    | 7      | c | <i>Friday</i>    |

As the former Table shewed, how 4.  
 it comes to pass, that G is the *Sunday*-  
*Letter* for 1711, and *F* for 1712, at  
 the Beginning of the said Year, even  
 to *February* 23<sup>d</sup> ; so this later Table  
 shews

The inter-  
 calated  
 Day makes  
 a double  
 Change  
 in the Sun-



CHAP. shews, how it comes to pass, that af-

IV. ter *February 23d*, not *F* as afore, but  *E* is the *Sunday-Letter* for the Rest of the Year. And consequently as the former Table will serve to shew, how by the odd Day in a common Year, there is made every common Year a *single* Change as to the *Sunday-Letter*; so the latter Table, compared with the former, will shew how by the intercalated Day of a Leap-Year there is made after *February 23d*, in every Leap-Year another Change of the *Sunday-Letter*, besides the former made at the Beginning of the said Leap-Year; and consequently how there comes a *double* Change of the *Sunday-Letter* every Leap-Year.

5.  
This Cycle  
why con-  
sists of  
twenty-  
eight  
Years.

Now as the Cycle of the *Sunday-Letter* would have consisted but of seven Years, had there been only a single Change of the said Letter; so, by Reason of there being a double Change of the said Letter every Leap or fourth Year, it comes to pass, that the said Cycle consists of four Times seven Years, *i. e.* the *Sunday-Letter* does not proceed in the same Course as it did afore, under twenty-eight Years; and after that Number of Years

Years its Course or Order is the same CHAP. as it was afore. Which is illustrated IV. by the following Table; where it is to be observed, that the first Year, and every fourth Year after, of the Cycle is a Leap-Year, and therefore has two *Sunday-Letters* appertaining to it.

# A T A B L E of the Cycle of the S U N.

|      |      |      |       |       |       |       |
|------|------|------|-------|-------|-------|-------|
| 1 GF | 5 BA | 9 DC | 13 FE | 17 AG | 21 CB | 25 ED |
| 2 E  | 6 G  | 10 B | 14 D  | 18 F  | 22 A  | 26 C  |
| 3 D  | 7 F  | 11 A | 15 C  | 19 E  | 23 G  | 27 B  |
| 4 C  | 8 E  | 12 G | 16 B  | 20 D  | 24 F  | 28 A  |

To find what Year of this Cycle any 6. given Year of our Lord answers to, To find the and consequently, what is the *Sunday-Letter* for the Year given, work thus: *Cycle of the Sun for any given Year*  
To the Year of our Lord given (\*) of Christ. add 9, and divide the Sum by 28. If

(\*) The Reason of adding 9, is because the *Year* of Christ began in the Tenth Year of this Cycle.

CHAP. any of the Dividend remains, the said

IV. Remainder shews the Year of the Cycle sought; if nothing remains of the Dividend, then it is the last or 28<sup>th</sup> Year of the Cycle. For Instance, I would know, what Year of the Cycle of the Sun, A. D. 1712. answers to. By the foregoing Rule I find it to answer to the 13<sup>th</sup> Year of the said Cycle; (for  $1712 \div 9 = 1721$ , and 1721 being divided by 28, there will be left 13;) and by the Table of this Cycle I find the *Sunday-Letters* for the said Year, being a Leap-Year, to be *FE*, viz. *F* from the Beginning of *January* to *February 23<sup>d</sup>*, and after that *E* for the Rest of the Year, according to the (\*) *Julian Account*.

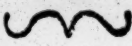
7.  
To find  
what Day  
of the  
Week the  
first Day of  
any Month  
falls upon.

It may not be altogether unuseful to observe further, that each of the first seven Alphabetical Letters always (as is afore noted) belonging to the same Day of each Month in the Year,

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(\*) Having found the *Sunday Letter* according to the *Julian Account*, the *Gregorian Sunday-Letter* will be the third in a backward Order from the *Julian*. Thus *FE* being the *Julian Sunday-Letters* for 1712, being Leap-Year, *C3* will be the *Gregorian Sunday-Letters* for the same.



hence the two following *English Verses* CHAP.  
shew by the first Letter of each Word, IV.  
what Letter belongs to the *first* Day of   
each Month ; the Order of the Words  
answering to the Order of the Months  
thus :

|              |                  |               |               |               |                 |
|--------------|------------------|---------------|---------------|---------------|-----------------|
| <i>Jan.</i>  | <i>Feb.</i>      | <i>March,</i> | <i>April,</i> | <i>May,</i>   | <i>June,</i>    |
| <i>At</i>    | <i>Dover</i>     | <i>Dwells</i> | <i>George</i> | <i>Brown</i>  | <i>Esquire,</i> |
| <i>July,</i> | <i>Aug.</i>      | <i>Sept.</i>  | <i>Oct.</i>   | <i>Nov.</i>   | <i>Dec.</i>     |
| <i>Good</i>  | <i>Christian</i> | <i>Faith,</i> | <i>And</i>    | <i>Doctor</i> | <i>Fryar.</i>   |

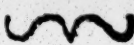
Wherefore the *Sunday-Letter* being known, it is easy by the Help of the foregoing Verses to tell, what Day of the *Week* the first Day of any Month falls upon ; namely, by considering the *Order* or *Distance* of the Letter belonging to the first Day of the given Month from the given *Sunday-Letter*.  
*Ex. gr.* I would know, what Day of the Week the first of *February* 1712. will be, when the *Sunday-Letter* will be (at that Part of the said Year) *F*. By the foregoing Verses I know *D* is the Letter belonging to *February* 1<sup>st</sup>, and therefore *F* being the *Sunday-Letter* *D*, (as being two in the Alphabetical Order before *F*) must denote *Friday*, which is agreeably two Days before *Sunday*.

In

CHAP. In like manner, if it be enquired,  
 IV. what Day of the Week *March 1<sup>st</sup>*  
 will fall upon in 1712, when the *Sunday-Letter* will be changed from *F* to *E*. It being known by the foregoing Verses, that *D*, is the Letter that belongs also to the first of *March*, it follows that, as *D* is the Letter next before *E*, so *March 1<sup>st</sup>* must fall on (that Day of the Week which is next before *Sunday*, viz.) *Saturday*.

8. It being thus to be known, what Day of the Week the *first* Day of any Month falls upon; thereby may be easily known also, what Day of the Week any *other* Day of the same Month falls upon; namely, by considering, that the *1<sup>st</sup>*, *8<sup>th</sup>*, *15<sup>th</sup>*, *22<sup>d</sup>*, and *29<sup>th</sup>* Day of any Month always fall upon the same Day of the Week; and then reckoning, how far distant the Day proposed is from any of the aforesaid Days. For instance, I would know, what Day of the Week *March 18<sup>th</sup>* falls upon next Year, viz. 1712. It being afore known, that the first Day of *March* will then fall on *Saturday*, it follows, that *March 15<sup>th</sup>* will be likewise on *Saturday*; and therefore *March 18<sup>th</sup>* (as being three Days after

To find  
 what Day  
 of the  
 Week any  
 other Day  
 of the  
 Month (be-  
 sides the  
 first) falls  
 upon.

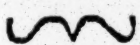
after *March 15th*) will fall on *Tuesday*, CHAP.  
as being three Days after *Saturday*. And IV.  
therefore, by the *Sunday-Letter* and the   
foregoing Verses, may be found, what  
Day of the *Week* any Day of the *Year*  
in general will fall upon. And thus we  
have largely shewn the Use of the Cycle  
of the Sun, or of the *Sunday-Letter*.





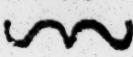
## C H A P. V.

*Of the* INDICTION, *and* JULIAN  
P E R I O D.

CHAP. V.  I. *Of the Indiction.* THE Indiction is a Cycle of fifteen Years, which has no Relation to any Celestial Motion, but was instituted wholly on a Political or Civil Account, *viz.* in respect to certain Taxes (as is the most received Opinion) which were to be paid every fifteen Years. When this Cycle was first instituted, is not left upon Record; but it is evident from History, that it has been in Use ever since the Time of *Constantine* the Great, or from A. D. 312. It was used both by the *Greeks* and *Romans*, but after (\*) a manner somewhat different. The *Roman* Indiction is still used by the *Pope* in his Bulls, &c. And the Year of the *Roman* Indiction an-

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(\*) The *Greek* Indiction begins from the first of *September*, the *Roman* Indiction from the first of *January*. And the former is used in the *Acts of Councils*, and the *Novels* of the *Emperors*.

Answering to any given Year of Christ is CHAP.  
found, by (\*) adding 3 to the given V.  
Year of Christ, and dividing the Sum   
by 15. The Remainder of the Divi-  
dend, if any there be, shews the Indic-  
tion; if nothing remains, then it is the  
15th or last Year of the Indiction. The  
principal Reason of taking Notice of this  
Cycle in this Treatise, is because it con-  
duces to the Understanding of the *Ju-  
lian Period*, of which we shall speak  
next.

The *Julian Period* is no other than 2.  
a greater Cycle, made up of the three <sup>Of the Ju-</sup>  
fore-mentioned Cycles of the Moon, <sup>lian Pe-</sup>  
Sun, and Indiction, multiplied one into <sup>riod.</sup>  
the other, and so consisting of 7980  
Years. For the Cycles of the Moon  
and Sun, viz. 19. and 28, being multi-  
plied together make (+) 532; which  
being multiplied again by 15, the Cycle  
of the Indiction, makes 7980, the Space

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(\*) The Reason of adding 3, is, because A. D. . began in the fourth Year of the said *Roman* Indiction.

(+) This Number of Years, arising from the Cycles of the Moon and Sun being multiplied together, is peculiarly stiled the *Dionysian* Period, and also the *Victorian* Period, from Persons of the like Names, who introduced the Use thereof.

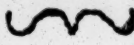
CHAP. of the *Julian Period*. It is called the  
 V. *Julian Period*, because it was adapted  
 by the Author or Inventor of it, *Joseph Scaliger*, to the *Julian Year*, and its fore-mentioned Cycles. It is of excellent Use in Chronology, or Distinguishing of Times ; because the same Years of the Cycles of the Moon, Sun, and Indiction, which belong to any one Year of this *Julian Period*, will never fall together again till after 7980 Years, and consequently not as long as the World stands, according to the Opinion probably received concerning (\*) the Duration of the World. And as this Period will probably not expire before the *End* of the World, and thereby consequently may be distinguished the Times of all *Future* Events ; so it extends backwards (†) before the *Begin-*

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(\*) Namely, That it shall endure but 6000 Years. Of which about 4000 Years being expired before our Saviour's Nativity, and somewhat above 1700 Years being expired since, there remains but about 300 Years more for the World to last, according to the said Opinion.

(†) Namely, *Julian Period* 4714, answering to A.D. 1. and our Saviour being born but about the 4000th Year of the World, it thence follows, that the *Julian Period* must be conceived to commence or begin about 700 Years before the Creation.



ning of the World, and thereby conse- CHAP.  
quently may be distinguished the Times V.  
of all *Past* Events from the very Crea-   
tion. Hence Chronologers do endea-  
vour to adjust all other Accounts of  
Time, and consequently all Transactions  
and Events recorded in History, to the  
*Julian Period*.

To find what Year of the *Julian* 3.  
*Period* any given Year of Christ answers To find  
what Year  
of the Ju-  
lian Period  
answers to  
any given  
Year of  
Christ.  
to, work thus. To the given Year of  
Christ add 4713, (because so many  
Years of the *Julian Period* were expi-  
red before A. D. 1.) and the Sum gives  
the Year of the *Julian Period* sought.  
For instance, I would know, what Year  
of the *Julian Period* A. D. 1712. an-  
swers to. Now  $1712 + 4713 = 6425$ ,  
the Year sought of the *Julian Period*.

On the contrary, having the Year of 4.  
the *Julian Period* given to find what To find  
what Year  
of Christ  
answers to  
any given  
Year of the  
Julian Pe-  
riod.  
A. D. answers thereto, work thus. From  
the Year of the *Julian Period* given,  
subtract 4713; (for the Reason above-  
mentioned,) and the Residue will be the  
A. D. sought. For instance, I would  
know, what A. D. answers to the *Ju-  
lian Period* 6425. Wherefore  $6425 -$   
 $4713 = 1712$ , the A. D. sought.

CHAP. If the Year of the *Julian Period* gi-

V. ven be 4713, or less than it, then subtract the same from 4714, (which is

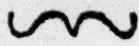
5. the Year of the *Julian Period*, that answers to A. D. 1.) and the Residue will shew, how long afore (the Beginning of the common Computation from the Nativity of) Christ the given Year of the *Julian Period* was. For instance, the City of *Rome* is said to have been built, *J. P.* 3960. I would know therefore, how long it was built before Christ. Now  $4714 - 3960 = 754$ . Wherefore *Rome* was built 754 Years before (the Beginning of the common *Æra* of) Christ.

To find  
what Year  
before  
Christ an-  
swers to  
any given  
Year of the  
Julian  
Period, less  
than 4714.

6. To know what Year of the Cycle of the Sun, Moon, or Indiction, answers to any Year given of the *Julian Period*; divide the given Year respectively by 28, or 19, or 15. The Remainder of the first Division will shew the Year of the Sun's Cycle; the Remainder of the second Division will shew the Year of the Moon's Cycle; and of the third Division, the Year of the Indiction. If nothing remains in each Division, then it is the last Year of each Cycle respectively.

To find the  
Cycle of  
the Sun,  
Moon, or  
Indiction,  
answering  
to any Year  
of the Ju-  
lian Pe-  
riod.

On

On the contrary, to know what Year CHAP. V.  
of the *Julian Period* answers to any gi-  
ven Year of the Cycle of the Sun, or   
Moon, or Indiction; multiply the Cy- 7.  
cle of the Sun into 4845, the Cycle of And the contrary.  
the Moon into 4200, the Cycle of the  
Indiction into 6916. The Sum of the  
Products being divided by 7980, the  
Remainder will shew the Year of the  
*Julian Period* sought.

And thus we have gone through the 8.  
several Characters of Time, whose Com- Cycles and  
putation after a certain Number of Years Periods,  
begins anew; whence each of them is why so  
stiled, either a *Cycle*, as the Cycle of the called.  
Sun, Moon, and Indiction; or a *Period*,  
as the *Julian Period*.





C H A P. VI.

*Of EPOCH's or ÆRA's; and especially  
of the ÆRA or Year of CHRIST, the  
ÆRA of the OLYMPIADS, and the  
ÆRA of the BUILDING of ROME.*

C H A P.  
VI.

**W**E are now to speak of those Characters of Time, whose Computation does not begin a-new after a certain Number of Years, but is still continued on further and further from their respective Heads or single Beginnings. And these are distinguished from the circular Characters of Time already described, by the Name of (\*) *Epoch's* or *Æra's*.

2. There are several *Epoch's* or *Æra's* made use of, both formerly and at present, in the several Parts of the

*Of the  
Æra of  
Christ,  
used by Us  
and other  
Christians.*

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(\*) These Words are frequently used promiscuously. Some take an *Æra* to denote properly any *continued Computation*, and an *Epoch* to signify properly the *Beginning* of the said Computation; the Greek Word *ἐποχή* denoting (as it were) a Pause or Stop in Time, from whence Time is computed. As to the Etymology of *Æra*, there is no good Account of it.

World,

World. That of principal Concern to CHAP.  
us Christians is the *Æra* of *Christ*, or VI.  
the common Way of computing Time ~~~~~  
from the Nativity of Christ; according  
to which this present Year is reckoned  
the 1711<sup>th</sup> from the *Nativity* of Christ,  
or rather from the *first of January* next  
following the Nativity of Christ, ac-  
cording to the common Computation  
generally receiv'd in *Christendom*, or  
*Europe*. The *Æra* or Way of recko-  
ning from *Christ*, was first introduced  
by one *Dionysius*, surnamed (\*) *Exiguus*,  
somewhat more than 500 Years after  
Christ: Since which Time Christians  
have reckoned their Years, either from  
the Birth or Incarnation of our Blessed  
Saviour; whereas before they were wont  
to reckon some other Ways. According  
to *Dionysius*, the Author of the *Æra*  
computed from Christ, our Lord was  
conceived on the 8<sup>th</sup> of the Calends of  
*April* (now called *Lady-Day*) in the  
first Year of this *Æra*; and was Born  
about the then Winter-Solstice next  
following; that is, *December 25*.—  
And this Account was at first univer-

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(\*) He was so surnamed from his little Stature.

CHAP. fully received among Christians: but  
 VI. is now a-days used only in *England*  
 and *Ireland*, where not only the Ecclesiastical, but also the Civil Year, is still reckoned according to Law, from the *Feast of the Annunciation*, or *Lady-Day*, as it was at first by *Dionysius* himself. Whereas in other parts of *Christendom*, as is afore observ'd, and even in *England* as to common Affairs which require not a Legal (Ecclesiastical or Civil) Date, the Year of Christ is reckoned now a-days, not from the *Annunciation* or *Lady-Day*, but from the *First of January* next before the *Lady-Day* from which the Legal Date of our Ecclesiastical or Civil Year begins. It is also to be observ'd, that the Common Account by *A. D.* introduced by the foresaid *Dionysius Exiguus* does not agree exactly to the *True Years of Christ's Age*. Forasmuch as according thereto, *Herod the Great* must be dead before our Saviour was born, which is contrary to the Gospel History. How much the Difference between the True and Common Account is, the Learned are not agreed. But I prefer that Opinion, which makes the common Account



count *too little* by *two* Years. So that CHAP. VI.  
whereas this present Year is *Commonly* esteem'd *A. D.* 1711, it is *Truly A. D.* 1713, or the 1713<sup>th</sup> Year from the *Birth of Christ* or *January 1.* next ensuing.

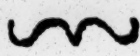
There is also another *Æra* frequently made Use of by Christian Writers, namely, the *Æra* of the *Creation*, which is generally agreed to have been about 4000 Years before Christ. And because to say such or such a Thing fell out in such a Year of the *World*, does not give us so clear an Idea of the Distance of the said Occurrence from us, as it does to say, that it happened in such or such a Year *before Christ*; therefore, the Computation from the Creation of the World begins to be laid aside, even in Matters relating to the Sacred History of the Old Testament, and instead thereof the Occurrences of the Old Testament are now a-days computed by their Distance *before Christ*. Thus instead of saying, that the *Universal Deluge* happened *A. M.* or in the Year of the *World* 1656, it is thought more Instructive to say, that it happened 2294 Years *before Christ*, this last

3.  
Of the  
Æra of the  
World, or  
Creation.

CHAP. Manner of Computation giving us a  
 VI. clearer Notion of the Time when the  
 ~~~~~ Flood happened in respect of its Distance from us. For we being wont to reckon our Time *from Christ*, and so reckoning this present Year to be the 1711<sup>th</sup> from Christ; when we are told, that the Flood was 2294 *before* Christ, we can from thence easily gather, that the Flood was about 4000 Years ago in respect of this present Time. And on the same Considerations, it appears to be much the best or easiest and clearest Way for us, to compute likewise all Occurrences mentioned in any other as well as the Sacred History, by their Distance either *before* or *after* Christ; and so to make the *Nativity of Christ* the Universal *Head* or *Epoch* of all Chronology, counting therefrom all Occurrences either *Backward* or *Forward*.

4.
 of the
 Era of the
 Olympi-
 ads.

The most Antient and Renowned *Epoch* used by the Heathens is that of the *Olympiads* or *Olympick Games*, which were instituted by one *Iphitus*, in the Fields of *Olympia*, a City or Town of the Region *Elis* in the *Peloponnese*; and which lasted five Days, the last whereof fell on the Full Moon,
 which

which was next after the Summer Sol- CHAP.
stice. These Games were celebrated e- VI.
very four Years, *that is*, there were three 
Years between the Years wherein the
next preceding and the next following
Olympiad was celebrated. Hence by a
compleat *Olympiad*, is denoted the Space
of four Years; the Year wherein the
Olympiad was celebrated, being stiled the
first Year of the said *Olympiad*, and so
on. The Celebration of the first *Olym-*
piad is referred to the 3938th Year of
the *Julian Period*; and consequently to
the 777th Year *before Christ*, viz. to the
Calends of *July*, in the Summer of the
said Years. Wherefore,

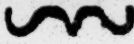
Any Year of the *Olympiads* being
given, to find the correspondent Year of ^{5.}
the *Julian Period*, work thus; Mul- ^{To find the}
tiply the compleat *Olympiads* by 4, and ^{Year of the}
to the Product add the Year (if it be ^{Julian Pe-}
given) of the *Olympiad* running, and ^{riod an-}
also 3937, the Sum is the Year of ^{swering to}
the *Julian Period* sought. For Instance, ^{any Year}
Rome is said to be built, according to ^{given of}
Varro's Account, in the fourth Year of ^{the Olym-}
the sixth *Olympiad*. Wherefore I mul- ^{piads.}
tiply 5 (the Number of the compleat
Olympiads) by 4, which makes 20,
and thereto I add 4 more, (the Year
given

CHAP. given of the *Olympiad* running, or 6th
VI. *Olympiad*,) and also 3937. All which
~~~~~ together amounts to 3961, the Year  
sought of the *Julian Period*.

6. Having found the Year of the *Julian Period* answering to any given Year of the *Olympiads*, thereby may also be found the correspondent Year (respectively) before or after Christ, Namely, if the Year found of the *Julian Period* be less than 4713, then subtract the same from 4713, and the Remainder will shew the correspondent Year *before* Christ: But if the Year found of the *Julian Period* be greater than 4713, then subtract 4713 from it, and the Remainder will shew the correspondent Year *after* Christ. Thus, it being found, that *Rome* was built in *Julian Period* 3961, I subtract 3961 from 4713, and there remains 752, the correspondent Year *before* Christ wherein *Rome* was built.

7. But if there be no Occasion to find the correspondent Year of the *Julian Period*, the Year before or after Christ, respectively answering to any given Year of the *Olympiads* may be found thus. Multiply (as afore) the compleat *Olympiads* by 4, and to the Product add the

Another  
Way to find  
the Year  
of Christ  
answering  
to any  
Olympick  
Year.

the Year given (if any be specified ) of CHAP.  
 the *Olympiad* running. This Sum, if it VL  
 be less than 776, subtract it from 776,   
 and the Remainder will shew the corres-  
 pondent Year *before* Christ: but if the  
 Sum be greater than 776, then subtract  
 776 from it, and the Remainder will  
 shew the correspondent Year *after* Christ.  
 Thus I would know what Year of Christ  
 answers to the fourth Year of the sixth  
*Olympiad*, wherein Rome was built ac-  
 cording to *Varro*. Wherefore ( as afore )  
 $5 \times 4 = 20$ , and  $20 + 4 = 24$ . Which  
 Sum being less then 776, I subtract it  
 from 776, and there will remain 752,  
 the correspondent Year *before* Christ, as  
 was found before by the other Method.

Any Year of the *Julian Period* be- 8.  
 ing given, to find what *Olympick* Year To find  
 answers thereto, work thus: From the what O-  
 Year given subtract 3937, and divide lympick  
 the Remainder by 4, the Quotient Year an-  
 will shew the compleat *Olympiads*, and swers to  
 the Fraction or Remainder of the Di- any given  
 vidend will shew the Year of the *Olym-* Year of the  
*piad* running. If there be no such Re- Julian Pe-  
 mainder, then it is the last or fourth riod.  
 Year of the *Olympiad* running *Ex. gr.*  
 I would know, what *Olympick* Year an-  
 swers to *J. P.* 3961. From 3961, I  
 subtract

CHAP. subtract 3937, and there remains 24;

VI. which divided by 4, gives 6 in the Quotient, and leaves no Fraction of the Dividend. Wherefore the *Olympick* Year fought, is the fourth Year of the sixth *Olympiad*.

9.  
Of the  
Æra of  
U. C. or  
the Build-  
ing of  
Rome.

As the Account by the *Olympiads* was, the principal *Æra* among the *Greeks*; so the principal *Æra* among the *Romans* was, that of the (\*) *U. C.* or *Building of Rome*; which, according to *Varro* began *Julian Period*, 3961, but according to the *Fasti Capitolini* in the following Year, viz. *Julian Period* 3962. Wherefore,

10.  
To find the  
Year of the  
*Julian Pe-  
riod* an-  
swering to  
any given  
Year of  
U. C.

Any Year of *U. C.* being given, add thereto 3960, and you'll have the correspondent Year of the *Julian Period*, according to *Varro's* Account; or add 3961, and you'll have the correspondent Year of the *Julian Period*, according to the *Capitoline* Account.

On the contrary, from the given Year of *Julian Period*, subtract 3960, and the Residue will give the Year of *U. C.* according to *Varro*; or sub-

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(\*) *U. C.* are the Initial Letters of *Urbs Condita*, and so are put to denote in short the *Building of the City*, viz. *Rome*.



tract 3961, and the Residue will be the CHAP.  
Year of U. C. according to the Capito- VI.  
line Account.

Forasmuch as *Rome* is computed to 11.  
have been built 752 Years before Christ; To find the  
therefore from 752 subtract any given Year be-  
Year of U. C. less than the same, and fore or af-  
the Residue will shew the correspondent ter Christ,  
Year before Christ: Or if the Year given answering  
of U. C. be greater than 752, then sub- to any gi-  
tract 752 from it, and the Residue will ven Year  
shew the correspondent Year after of U. C.  
Christ. Thus the Regal State of *Rome*  
is computed to have ended in U. C.  
245, to which answers the Year 507 be-  
fore Christ: for  $752 - 245 = 507$ . And  
the Removal of the Imperial Seat from  
*Rome* to *Constantinople* by *Constantine*  
the Great, is computed to have hap-  
pened U. C. 1084, and so 332 Years  
after Christ: for  $1084 - 752 = 332$ .

As for other *Epoch's* or *Æra's*, they 12.  
being of less Note and Use to us, it Of other  
will be sufficient to shew in short, how Epoch's or  
long before or after Christ each of them Æra's:  
began,

Q

The

CHAP.  
VI.

Before Christ.

~~~~~ The *Destruction of Troy*,  
is computed to fall in with
(*) *Julian Period*, 3531, } 1183
and so the *Æra* taken
from thence to begin.

The *Æra* of *Nabonassar*
King of *Babylon*, from the
Beginning of whose Reign
the *Chaldeans* and *Egypti-* } 747
ans reckoned their Years,
began *February* 26. *J. P.*
3967, and consequently

The *Æra* (†) of the
Death of *Alexander* the } 324
Great, began *Novemb.* 12.
J. P. 4390, and so

(*) Herein is followed the Opinion of *Dionysius Halicarnassens*, and *Diodorus Siculus*.

(†) Some distinguish between the *Alexandrian Æra*, and the *Philippean*, making the *Philippean* (so called from *Philip Aridaus*, Brother to *Alexander* the Great) to begin from the Death of *Alexander*, or more exactly from the 12th of *November* following the Death of *Alexander*, and so *Julian Period*, 4390; and the *Alexandrian* to begin not till twelve Years after *Alexander's* Death, viz. *October* 1st, *Julian Period*, 4402. This latter *Æra* is esteemed by some learned Men to be the same with the *Æra Seleucidarum*, otherwise called *Æra Contractuum*, and the Years of the Greeks in the Books of the *Maccabees*.

The

Before Christ.

The *Æra* of the City
Antioch, used by *Eusebi-*
us, *Evagrius*, *Cedrenus*,
&c. began from the Au-
tumn *J. P.* 4665, and so

49

The *Æra* of the *Ju-*
lian Reformation of the
Calendar, began *January*
1, *J. P.* 4669, and so

45

The *Æra Actiaca*, so
denominated from the
Victory obtain'd by *Au-*
gustus over *Anthony* at
Actium, began *August* 29,
J. P. 4684, and so

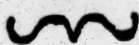
30

Before Christ.

The *Dioclesian Æra*,
or *Æra* of the (*) Mar-
tyrs, otherwise called the
Æra of the *Abissinians*,
began *August* 29. A. D.

284

(*) So called from the Multitude of Christians that
suffered *Martyrdom* in the *Dioclesian* Persecution.

CHAP.
VI.

After Christ,

The *Æra* of the *Hegira*,
or Flight of *Mahomet* from
Mecca to *Medina*, used by
the *Turks* and *Arabs*, be- } 622
gan July 16, A. D.

The *Æra* of *Yezdegird*,
or the *Persian Æra*, began } 632
July 16, A. D.

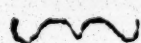
From this Table of the Beginnings of the fore-mentioned *Æra's*, it is easy to find out the Year before or after Christ, which answers to any Year given of any of the said *Æra's*, which are computed by *Julian* Years; as are the *Æra's* of the Destruction of *Troy*, of the *Julian* Reformation, of *Dio- clesian*, &c. But it is more difficult to do so in respect of the *Æra* of *Nabonassar*, of *Alexander's* Death, and of the *Hegira*, because they are computed by Years different from the *Julian* Years. It will be sufficient to our present Design to observe here, that 1461 *Nabonassar* Years,

Years, make only 1460 *Julian* Years; CHAP.
and the same is to be understood VI.
of the *Alexandrian* Years, as being ~~~~~
of the same Kind with the *Nabo-*
nassars.



C H A P. VII.

Of the Method to find EASTER-DAY, according to the NICENE Rule, (as still followed by our Church,) by the Help of the Golden Numbers affixed to the Calendar. To which is adjoined the ROMAN Method of DATING, or denoting the Days of the Month.

C H A P.
VII.

I.

The Nicene Rule for finding Easter-Day.

THE Rule prescribed by the Fathers of the *Nicene Council* for the finding of *Easter*, and which is still followed by the Church of *England*, is thus expressed in our *Common-Prayer-Book*: (*) *Easter-Day is always*

(*) It is observable that the *Nicene Fathers* in prescribing this Rule did not act arbitrarily, but conformed themselves as near as the Difference of Circumstances would permit, to the Rule prescrib'd by God for observing the *Passover*. Namely, the Rule for the *Jewish Passover* was, that it should be kept on the *Fourteenth Day*, which is much the same as on the *Full Moon* of the first Ecclesiastical Month called *Nisan*. And the *Nicene Rule* for *Easter* is, that it shall be kept on the *Sunday* next after the *Fourteenth Day* or *First Moon* of our First Ecclesiastical Month, or that part of our *March*, which answers to the Jewish Month *Nisan*.

I

the

the first Sunday after the first Full Moon, CHAP. VII. which happens next after the One and Twentieth Day of March. And if the Full Moon happens upon a Sunday, Easter-Day is the Sunday after.

According to this Rule, *Easter-Day* 2. may easily be found by the Help of the Golden Numbers (*) duly affixed to the Calendar, and by retaining in Memory, and applying to Practice, what has been said of the Golden Numbers, and Dominical Letter, *Chap. 3d and 4th.*

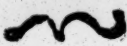
To find Easter-Day according to the said Rule, by the Help of the Golden Numbers.

For Instance, I would know, what Day *Easter-Day*, will fall upon the next Year, *viz. 1712.* In order hereto, first I enquire what is the *Golden Number* for the given Year, and I find it to be three, according to the Rule given *Chap. III. Sect. 6.* Then I enquire what is the Dominical or *Sunday Letter* for the given Year, and (according to the Rules given, *Chap. IV. Sect. 5, 6.*) I find

(*) In our old large Common Prayer-Books, great Care was taken duly to affix the Golden Numbers to their proper Days; and to that End black Lines were drawn between every Day of the Calendar. But of late Years no such Care is taken, insomuch that it is not to be known with any certainty what Days the Golden Numbers do answer to in the Church-Calendars, of late printed without such black Lines.

CHAP. that there will be two *Sunday* Letters VII. next Year, it being Leap-Year. Of which two Letters, viz. *FE*, the latter *E* will be the *Sunday* Letter after *Feb. 23d*, and so that whereby I am to be guided in finding out *Easter-Day*.

Now because the Full Moon, on which *Easter* depends, is (according to the *Nicene* Rule) that which happens next after the *21st of March*; and because the said Full Moon is (agreeably to *Exod. xii. 6.*) to be esteemed the *14th Day* after its New Moon inclusively, (*i. e.* the Day of the said New Moon, being reckoned the first of the *14th*, and the Day of the Full Moon the last,) hence the said *Easter* New Moon can never fall before the *9th of March*, nor after the *5th of April*. Wherefore I look for the Golden Number 3 between *March 9th*, and *April 5th*, and find it placed to *March 31st*, which therefore was the Day on which the *Easter* New Moon fell at the Time of the *Nicene* Council, in the 3d Year of the Moon's Cycle: and consequently is esteemed so still by us. Wherefore the *Easter* Full Moon (being fourteen Days after inclusively) will be *April 13th*; which being shewn by the Letter

ter E affix'd to it to be a *Sunday*, there-
fore, by the *Nicene Rule*, *Easter-Day* VII.
must be the *Sunday* after, viz. *April* 
20th. And in like manner may *Easter-*
Day be found for any other given Year,
by the Help of the Calendar adjoined
to the End of this Chapter; and con-
sequently Tables may be made, shewing
the Day, whereon *Easter* will fall, for
any Term of Years.

It remains now only to observe, that
in Order to render the following Ca-
lendar more useful, therein is set down
the *Roman Manner of Dating*, or de-
noting the several Days of the Year.
Where it is to be noted, that the *Roman*
Numbers between the Words *Kalends*,
Nones, *Ides* and *Calends* of the succeed-
ing Month, do respectively refer always
to the following Word. Thus the Num-
ber IV over against *January 2d*, refers
to the following *Nones*, and denotes as
much as the *4th* Day of, or before the
Nones of *January*. So XI set to *Janu-*
ary 22d, denotes the *11th* of, or before
the *Calends* of *February*.

Wherefore any *Roman Date* given,
may be turned into *our Date*, by
finding in the Calendar the Date given,
(suppose 3 *Id. Februar.*) and seeing
what

3.

Of the Ro-
man way
of Dating,
or denoting
the Days of
the Year.

CHAP. what Date of ours answers thereto, (*viz.*
 VII. *February the 11th.*) And on the other
 ~~~~~ hand, any Date of ours being given,  
*v. g. January 31st* ; it may be turned  
 into the *Roman* Date, by finding the  
*Roman* Date affixed thereto, *viz. Prid.*  
*Kal. Febr.*



*January*

Golden  
 Number

3 .

11 .

19 .

8 .

16 .

5 .

13 .

2 .

10 .

18 .

7 .

15 .

4 .

12 .

1 .

9 .

17 .

6 .

14 .

3 .

| JANUARY        |               |                 |             | FEBRUARY       |               |                 |             |
|----------------|---------------|-----------------|-------------|----------------|---------------|-----------------|-------------|
| Golden Number. | Day of Month. | Weekly Letters. | Roman Date. | Golden Number. | Day of Month. | Weekly Letters. | Roman Date. |
| 3 . .          | . 1           | A               | Calendæ     |                | 1             | D               | Calendæ     |
|                | 2             | B               | IV          | 11 .           | . 2           | E               | IV          |
| 11 . .         | . 3           | C               | III         | 19 .           | . 3           | F               | III         |
|                | 4             | D               | Prid.       | 8 .            | .. 4          | G               | Prid.       |
| 19 .           | . 5           | E               | Nonæ        |                | 5             | A               | Nonæ        |
| 8 . .          | . 6           | F               | VIII        | 16 .           | . 6           | B               | VIII        |
|                | 7             | G               | VII         | 5 . .          | . 7           | C               | VII         |
| 16 . .         | 8             | A               | VI          |                | . 8           | D               | VI          |
| 5 . .          | . 9           | B               | V           | 13 .           | . 9           | E               | V           |
|                | 10            | C               | IV          | 2 .            | . 10          | F               | IV          |
| 13 . .         | . 11          | D               | III         |                | 11            | G               | III         |
| 2 . .          | . 12          | E               | Prid.       | 10 .           | . 12          | A               | Prid.       |
|                | 13            | F               | Idus.       |                | 13            | B               | Idus.       |
| 10 . .         | . 14          | G               | XIX         | 18 .           | . 14          | C               | XVI         |
|                | 15            | A               | XVIII       | 7 .            | . 15          | D               | XV          |
| 18 . .         | . 16          | B               | XVII        |                | 16            | E               | XIV         |
| 7 .            | . 17          | C               | XVI         | 15 .           | . 17          | F               | XIII        |
|                | 18            | D               | XV          | 4 .            | . 18          | G               | XII         |
| 15 .           | . 19          | E               | XIV         |                | 19            | A               | XI          |
| 4 .            | . 20          | F               | XIII        | 12 .           | . 20          | B               | X           |
|                | 21            | G               | XII         | 1 .            | . 21          | C               | IX          |
| 12 . .         | . 22          | A               | XI          |                | 22            | D               | VIII        |
| 1 .            | . 23          | B               | X           | 9 .            | . 23          | E               | VII         |
|                | 24            | C               | IX          |                | 24            | F               | VI          |
| 9 .            | . 25          | D               | VIII        | 17 .           | . 25          | G               | V           |
|                | 26            | E               | VII         | 6 .            | . 26          | A               | IV          |
| 17 . .         | .. 27         | F               | VI          |                | 27            | B               | III         |
| 6 .            | . 28          | G               | V           | 14 .           | . 28          | C               | Prid. Kal.  |
|                | 29            | A               | IV          |                |               |                 |             |
| 14 .           | . 30          | B               | III         |                |               |                 |             |
| 3 .            | .. 31         | C               | Prid. Kal.  |                |               |                 |             |

Golden

| MARCH             |                  |                    |                | APRIL             |                  |                    |                |
|-------------------|------------------|--------------------|----------------|-------------------|------------------|--------------------|----------------|
| Golden<br>Number. | Day of<br>Month. | Weekly<br>Letters. | Roman<br>Date. | Golden<br>Number. | Day of<br>Month. | Weekly<br>Letters. | Roman<br>Date. |
| 3 . .             | 1                | D                  | Calendæ        |                   | 1                | G                  | Calendæ        |
|                   | 2                | E                  | VI             | 11 .              | 2                | A                  | IV             |
| 11 . .            | 3                | F                  | V              | 19 .              | 3                | B                  | III            |
|                   | 4                | G                  | IV             | 8 .               | 4                | C                  | Prid.          |
| 19 . .            | 5                | A                  | III            |                   | 5                | D                  | Nonæ           |
| 8 . .             | 6                | B                  | Prid.          | 16 .              | 6                | E                  | VIII           |
|                   | 7                | C                  | Nonæ           | 5 .               | 7                | F                  | VII            |
| 16 . .            | 8                | D                  | VIII           |                   | 8                | G                  | VI             |
| 5 . .             | 9                | E                  | VII            | 13 .              | 9                | A                  | V              |
|                   | 10               | F                  | VI             | 2 .               | 10               | B                  | IV             |
| 13 .              | 11               | G                  | V              |                   | 11               | C                  | III            |
| 2 .               | 12               | A                  | IV             | 10 .              | 12               | D                  | Prid.          |
|                   | 13               | B                  | III            |                   | 13               | E                  | Idus.          |
| 10 . .            | 14               | C                  | Prid.          | 18 .              | 14               | F                  | XVIII          |
|                   | 15               | D                  | Idus.          | 7 .               | 15               | G                  | XVII           |
| 18 . .            | 16               | E                  | XVII           |                   | 16               | A                  | XVI            |
| 7 . .             | 17               | F                  | XVI            | 15 .              | 17               | B                  | XV             |
|                   | 18               | G                  | XV             | 4 .               | 18               | C                  | XIV            |
| 15 . .            | 19               | A                  | XIV            |                   | 19               | D                  | XIII           |
| 4 .               | 20               | B                  | XIII           | 12 .              | 20               | E                  | XII            |
|                   | 21               | C                  | XII            | 1 .               | 21               | F                  | XI             |
| 12 . .            | 22               | D                  | XI             |                   | 22               | G                  | X              |
| 1 .               | 23               | E                  | X              | 9 .               | 23               | A                  | IX             |
|                   | 24               | F                  | IX             |                   | 24               | B                  | VIII           |
| 9 . .             | 25               | G                  | VIII           | 17 .              | 25               | C                  | VII            |
|                   | 26               | A                  | VII            | 6 .               | 26               | D                  | VI             |
| 17 . .            | 27               | B                  | VI             |                   | 27               | E                  | V              |
| 6 . .             | 28               | C                  | V              | 14 .              | 28               | F                  | IV             |
|                   | 29               | D                  | IV             | 3 .               | 29               | G                  | III            |
| 14 .              | 30               | E                  | III            |                   | 30               | A                  | Prid. Kal.     |
| 3 .               | 31               | F                  | Prid. Kal.     |                   |                  |                    |                |

Golden



| MAY               |                  |                    |                | JUNE              |                  |                    |                |
|-------------------|------------------|--------------------|----------------|-------------------|------------------|--------------------|----------------|
| Golden<br>Number. | Day of<br>Month. | Weekly<br>Letters. | Roman<br>Date. | Golden<br>Number. | Day of<br>Month. | Weekly<br>Letters. | Roman<br>Date. |
| 11 .              | 1                | B                  | Calendæ        |                   | 1                | E                  | Calendæ        |
|                   | 2                | C                  | VI             | 19 . . .          | 2                | F                  | IV             |
| 19 .              | 3                | D                  | V              | 8 . .             | 3                | G                  | III            |
| 8 .               | 4                | E                  | IV             | 16 . . .          | 4                | A                  | Prid.          |
|                   | 5                | F                  | III            | 5 . . .           | 5                | B                  | Nonæ           |
| 16 .              | 6                | G                  | Prid.          |                   | 6                | C                  | VIII           |
| 5 .               | 7                | A                  | Nonæ           | 13 . . .          | 7                | D                  | VII            |
|                   | 8                | B                  | VIII           | 2 . . .           | 8                | E                  | VI             |
| 13 .              | 9                | C                  | VII            |                   | 9                | F                  | V              |
| 2 .               | 10               | D                  | VI             | 10 . .            | 10               | G                  | IV             |
|                   | 11               | E                  | V              |                   | 11               | A                  | III            |
| 10 .              | 12               | F                  | IV             | 18 . . .          | 12               | B                  | Prid.          |
|                   | 13               | G                  | III            | 7 . . .           | 13               | C                  | Idus.          |
| 18 . .            | 14               | A                  | Prid.          |                   | 14               | D                  | XVIII          |
|                   | 15               | B                  | Idus.          | 15 . . .          | 15               | E                  | XVII           |
| 7 .               | 16               | C                  | XVII           | 4 . . .           | 16               | F                  | XVI            |
|                   | 17               | D                  | XVI            |                   | 17               | G                  | XV             |
| 15 .              | 18               | E                  | XV             | 12 . . .          | 18               | A                  | XIV            |
| 4 .               | 19               | F                  | XIV            | 1 . . .           | 19               | B                  | XIII           |
|                   | 20               | G                  | XIII           |                   | 20               | C                  | XII            |
| 12 . .            | 21               | A                  | XII            | 9 . . .           | 21               | D                  | XI             |
| 1 . .             | 22               | B                  | XI             |                   | 22               | E                  | X              |
|                   | 23               | C                  | X              | 17 . . .          | 23               | F                  | IX             |
| 9 . .             | 24               | D                  | IX             | 6 . . .           | 24               | G                  | VIII           |
|                   | 25               | E                  | VIII           |                   | 25               | A                  | VII            |
| 17 . .            | 26               | F                  | VII            | 14 . . .          | 26               | B                  | VI             |
| 6 . .             | 27               | G                  | VI             | 3 . . .           | 27               | C                  | V              |
|                   | 28               | A                  | V              |                   | 28               | D                  | IV             |
| 14 .              | 29               | B                  | IV             | 11 . . .          | 29               | E                  | III            |
| 3 .               | 30               | C                  | III            |                   | 30               | F                  | Prid. Kal.     |
|                   | 31               | D                  | Prid. Kal.     |                   |                  |                    |                |
| 11 .              |                  |                    |                |                   |                  |                    | Golden         |

| JULY              |                  |                    |                | AUGUST            |                  |                    |                |
|-------------------|------------------|--------------------|----------------|-------------------|------------------|--------------------|----------------|
| Golden<br>Number. | Day of<br>Month. | Weekly<br>Letters. | Roman<br>Date. | Golden<br>Number. | Day of<br>Month. | Weekly<br>Letters. | Roman<br>Date. |
| 19 . .            | 1                | G                  | Calendæ        | 8 . .             | 1                | C                  | Calendæ        |
| 8 . .             | 2                | A                  | VI             | 16 . .            | 2                | D                  | IV             |
|                   | 3                | B                  | V              | 5 . .             | 3                | E                  | III            |
| 16 . .            | 4                | C                  | IV             |                   | 4                | F                  | Prid.          |
| 5 . .             | 5                | D                  | III            | 13 . .            | 5                | G                  | Nonæ           |
|                   | 6                | E                  | Prid.          | 2 . .             | 6                | A                  | VIII           |
| 13 . .            | 7                | F                  | Nonæ           |                   | 7                | B                  | VII            |
| 2 . .             | 8                | G                  | VIII           | 10 . .            | 8                | C                  | VI             |
|                   | 9                | A                  | VII            |                   | 9                | D                  | V              |
| 10 . .            | 10               | B                  | VI             | 18 . .            | 10               | E                  | IV             |
|                   | 11               | C                  | V              | 7 . .             | 11               | F                  | III            |
| 18 . .            | 12               | D                  | IV             |                   | 12               | G                  | Prid.          |
| 7 . .             | 13               | E                  | III            | 15 . .            | 13               | A                  | Idus.          |
|                   | 14               | F                  | Prid.          | 4 . .             | 14               | B                  | XIX            |
| 15 . .            | 15               | G                  | Idus.          |                   | 15               | C                  | XVIII          |
| 4 . .             | 16               | A                  | XVII           | 12 . .            | 16               | D                  | XVII           |
|                   | 17               | B                  | XVI            | 1 . .             | 17               | E                  | XVI            |
| 12 . .            | 18               | C                  | XV             |                   | 18               | F                  | XV             |
| 1 . .             | 19               | D                  | XIV            | 9 . .             | 19               | G                  | XIV            |
|                   | 20               | E                  | XIII           |                   | 20               | A                  | XIII           |
| 9 . .             | 21               | F                  | XII            | 17 . .            | 21               | B                  | XII            |
|                   | 22               | G                  | XI             | 6 . .             | 22               | C                  | XI             |
| 17 . .            | 23               | A                  | X              |                   | 23               | D                  | X              |
| 6 . .             | 24               | B                  | IX             | 14 . .            | 24               | E                  | IX             |
|                   | 25               | C                  | VIII           | 3 . .             | 25               | F                  | VIII           |
| 14 . .            | 26               | D                  | VII            |                   | 26               | G                  | VII            |
| 3 . .             | 27               | E                  | VI             | 11 . .            | 27               | A                  | VI             |
|                   | 28               | F                  | V              |                   | 28               | B                  | V              |
| 11 . .            | 29               | G                  | IV             | 19 . .            | 29               | C                  | IV             |
|                   | 30               | A                  | III            | 8 . .             | 30               | D                  | III            |
| 19 . .            | 31               | B                  | Prid. Kal.     |                   | 31               | E                  | Prid. Kal.     |

Golden

# The CALENDAR.

83

| SEPTEMBER      |               |                 |             | OCTOBER        |               |                 |             |
|----------------|---------------|-----------------|-------------|----------------|---------------|-----------------|-------------|
| Golden Number. | Day of Month. | Weekly Letters. | Roman Date. | Golden Number. | Day of Month. | Weekly Letters. | Roman Date. |
| 16 . .         | 1             | F               | Calendæ     | 16 .           | 1             | A               | Calendæ     |
| 5 . .          | 2             | G               | IV          | 5 .            | 2             | B               | VI          |
|                | 3             | A               | III         | 13 . .         | 3             | C               | V           |
| 13 . .         | 4             | B               | Prid.       | 2 .            | 4             | D               | IV          |
| 2 . .          | 5             | C               | Nonæ        |                | 5             | E               | III         |
|                | 6             | D               | VIII        | 10 .           | 6             | F               | Prid.       |
| 10 . .         | 7             | E               | VII         |                | 7             | G               | Nonæ        |
|                | 8             | F               | VI          | 18 . .         | 8             | A               | VIII        |
| 18 . .         | 9             | G               | V           | 7 .            | 9             | B               | VII         |
| 7 .            | 10            | A               | IV          |                | 10            | C               | VI          |
|                | 11            | B               | III         | 15 . .         | 11            | D               | V           |
| 15 .           | 12            | C               | Prid.       | 4 .            | 12            | E               | IV          |
| 4 .            | 13            | D               | Idus.       |                | 13            | F               | III         |
|                | 14            | E               | XVIII       | 12 . .         | 14            | G               | Prid.       |
| 12 .           | 15            | F               | XVII        | 1 .            | 15            | A               | Idus.       |
| 1 . .          | 16            | G               | XVI         |                | 16            | B               | XVII        |
|                | 17            | A               | XV          | 9 .            | 17            | C               | XVI         |
| 9 .            | 18            | B               | XIV         |                | 18            | D               | XV          |
|                | 19            | C               | XIII        | 17 .           | 19            | E               | XIV         |
| 17 .           | 20            | D               | XII         | 6 .            | 20            | F               | XIII        |
| 6 .            | 21            | E               | XI          |                | 21            | G               | XII         |
|                | 22            | F               | X           | 14 .           | 22            | A               | XI          |
| 14 .           | 23            | G               | IX          | 3 .            | 23            | B               | X           |
| 3 .            | 24            | A               | VIII        |                | 24            | C               | IX          |
|                | 25            | B               | VII         | 11 .           | 25            | D               | VIII        |
| 11 .           | 26            | C               | VI          |                | 26            | E               | VII         |
| 19 .           | 27            | D               | V           | 19 .           | 27            | F               | VI          |
|                | 28            | E               | IV          | 8 .            | 28            | G               | V           |
| 8 .            | 29            | F               | III         |                | 29            | A               | IV          |
|                | 30            | G               | Prid. Kal.  | 16 .           | 30            | B               | III         |
|                |               |                 |             | 5 .            | 31            | C               | Prid. Kal.  |

Golden



| NOVEMBER          |                  |                    |                | DECEMBER          |                  |                    |                |
|-------------------|------------------|--------------------|----------------|-------------------|------------------|--------------------|----------------|
| Golden<br>Number. | Day of<br>Month. | Weekly<br>Letters. | Roman<br>Date. | Golden<br>Number. | Day of<br>Month. | Weekly<br>Letters. | Roman<br>Date. |
|                   | 1                | D                  | Calendæ        | 13 .              | 1                | F                  | Calendæ        |
| 13 . .            | 2                | E                  | IV             | 2 .               | 2                | G                  | IV             |
| 2 .               | 3                | F                  | III            |                   | 3                | A                  | III            |
|                   | 4                | G                  | Prid.          | 10 . .            | 4                | B                  | Prid.          |
| 10 .              | 5                | A                  | Nonæ           |                   | 5                | C                  | Nonæ           |
|                   | 6                | B                  | VIII           | 18 . .            | 6                | D                  | VIII           |
| 18 .              | 7                | C                  | VII            | 7 .               | 7                | E                  | VII            |
| 7 .               | 8                | D                  | VI             |                   | 8                | F                  | VI             |
|                   | 9                | E                  | V              | 15 .              | 9                | G                  | V              |
| 15 .              | 10               | F                  | IV             | 4 .               | 10               | A                  | IV             |
| 4 .               | 11               | G                  | III            |                   | 11               | B                  | III            |
|                   | 12               | A                  | Prid.          | 12 .              | 12               | C                  | Prid.          |
| 12 .              | 13               | B                  | Idus.          | 1 .               | 13               | D                  | Idus.          |
| 1 .               | 14               | C                  | XVIII          |                   | 14               | E                  | XIX            |
|                   | 15               | D                  | XVII           | 9 .               | 15               | F                  | XVIII          |
| 9 .               | 16               | E                  | XVI            |                   | 16               | G                  | XVII           |
|                   | 17               | F                  | XV             | 17 .              | 17               | A                  | XVI            |
| 17 .              | 18               | G                  | XIV            | 6 .               | 18               | B                  | XV             |
| 6 . .             | 19               | A                  | XIII           |                   | 19               | C                  | XIV            |
|                   | 20               | B                  | XII            | 14 .              | 20               | D                  | XIII           |
| 14 .              | 21               | C                  | XI             | 3 .               | 21               | E                  | XII            |
| 3 .               | 22               | D                  | X              |                   | 22               | F                  | XI             |
|                   | 23               | E                  | IX             | 11 .              | 23               | G                  | X              |
| 11 .              | 24               | F                  | VIII           |                   | 24               | A                  | IX             |
| 19 .              | 25               | G                  | VII            | 19 .              | 25               | B                  | VIII           |
|                   | 26               | A                  | VI             | 8 .               | 26               | C                  | VII            |
| 8 .               | 27               | B                  | V              |                   | 27               | D                  | VI             |
|                   | 28               | C                  | IV             | 16 .              | 28               | E                  | V              |
| 16 . .            | 29               | D                  | III            | 5 .               | 29               | F                  | IV             |
| 5 .               | 30               | E                  | Prid. Kal      |                   | 30               | G                  | III            |
|                   |                  |                    |                | 13 .              | 31               | A                  | Prid. Kal.     |
|                   |                  |                    |                |                   |                  |                    | Having         |

# Of finding EASTER-DAY.

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CHAP.

VII.

Having shewn how to find *Easter-Day*, according to the *Julian* or Old Account, used by Us in *Great Britain* and *Ireland*, it may not be improper to adjoin here, by way of Annotation, the Method of finding *Easter-Day* according to the *Gregorian* or New Account, used in all Countries where the *Popish* Religion is established. Now this is done by Help of the Table here subjoined, wherein in the first Column are contained the *Gregorian* Epacts, that are now and will be in Use till 1800 exclusively; and in the second Column are set down the Days whereon falls the *Easter* Full Moon; and in the third Column is set down the Weekly Letter answering to the said Days of the *Easter* Full Moon.

| Epacts. | Full Moons. | Weekly Letters. | Epacts. | Full Moons. | Weekly Letters. |
|---------|-------------|-----------------|---------|-------------|-----------------|
| X       | 13 April    | E               | IX      | 4 April     | C               |
| XI      | 2 April     | A               | XX      | 24 March    | F               |
| XXII    | 22 March    | D               | I       | 12 April    | D               |
| III     | 10 April    | B               | XII     | 1 April     | G               |
| XV      | 30 March    | E               | XXIII   | 21 March    | C               |
| XXV     | 18 April    | C               | IV      | 9 April     | A               |
| VI      | 7 April     | F               | XV      | 29 March    | D               |
| XVII    | 27 March    | B               | XXVI    | 17 April    | B               |
| XXVIII  | 15 April    | G               | VII     | 6 April     | E               |
|         |             |                 | XXVIII  | 26 March    | A               |

The Use of the foregoing Table is this. Having found (as is above shewn in the Note on Chap 3. Sect. 8. and Chap. 4. Sect. 6.) the *Gregorian* Epact and *Sunday-Letter*, over-gainst the said Epact in the foregoing Table is placed the Day whereon falls the *Easter* Full Moon, and thereto is affixed its respective Letter. From which therefore you are to reckon in an Alphabetical Order, till you come to the *Sunday-Letter* for that Year, and the Day of the Month answering to the said *Sunday-Letter*, is the *Gregorian Easter-Day*. Only if it happens, that the Full Moon falls on a *Sunday*, then (according to the *Nicene* Rule) the *Sunday* next following is the *Gregorian Easter-Day*. For Instance: It has been already (*viz.* in Notes on Chap. 3. Sect. 8. and Chap. 4. Sect. 6.) found, that

R

the

CHAP.  
VII.

the *Gregorian* Epact for A. D. 1712 is 22, and that the *Gregorian Sunday-Letters* are *CB*, viz. *C* to the intercalated Day in *February*, and after that *B*; which last Letter *B* is therefore the *Sunday-Letter*, whereby you are to be guided in finding *Easter-Day*. Now by the foregoing Table you learn, that when the *Gregorian* Epact is 22, the *Easter* Full Moon, according to the *Gregorian* Account, will fall on *March* 22d, N. S. (i. e. *March* 11th O. S.) to which answers the Letter *D*, as may be seen in the foregoing Calendar. Wherefore reckoning in an Alphabetical Order from *D* to *B*, which last is the *Gregorian Sunday-Letter*, you'll find, that according to the *Gregorian* Computation, *Easter-Sunday* will be *March* 27th N. S. which answers to our *March* 16th; and consequently the *Gregorian Easter-Day* will fall A. D. 1712, five Weeks before our *Easter-Day*, this falling on *April* 20th, as has been afore shewn.

It only remains to observe in short, that it having been shewn, how to find both the *Julian* and *Gregorian Easter-Day*, thereby may be known the Time of all the *Moveable Festivals* in any given Year; forasmuch as they all depend on *Easter-Day*. And consequently hereby, and by what has been said of finding the Days whereon fall the New and Full Moons, may be drawn up an *Almanack* sufficient for common Use. And thus I have laid together so much of Chronology, as seems requisite to be known by Young Gentlemen, at least at their first Institution in the said Art or Science.

F I N I S.





THE  
Young Gentleman's  
D I A L L I N G,

Containing such

ELEMENTS of the said Art,  
as are most useful and easy to  
be known.

---

B Y

EDWARD WELLS, D. D. late  
Rector of *Cotesbach* in *Leicestershire*.

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*The* FOURTH EDITION.

---

L O N D O N :

Printed for JAMES, JOHN, and PAUL  
KNAPTON, at the *Crown* in *Ludgate-Street*.  
MDCCXXXVI.





THE  
PREFACE.



*S the Dependance of  
the Art of Dialling  
upon Astronomy, was  
the Reason of my Draw-  
ing up and Publishing this Trea-  
tise, at the same Time with my  
Astronomical Treatise ; so my De-  
sign*



## THE PREFACE.

*sign in drawing up this Treatise, and the Reason of my giving it the Title of The Young Gentleman's Dialling, may be learnt from the Preface to my Treatise of Astronomy, entitled in like manner The Young Gentleman's Astronomy. I need only observe further, that I have not contented my self with laying down in this Treatise the bare Practical Part of Dialling, but have added thereunto the Reasons or Grounds of such Practice, as most proper to be known by Young Gentlemen; and withal have observed, in the Annotations to this Treatise, how the Grounds of Dialling may be most naturally represented even to the*  
*Eye,*

## The P R E F A C E.

*Eye, by the Help of a Machine  
or Instrument, which from its  
Use may be called a Dialling  
Sphere.*



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T H E  
C O N T E N T S.

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C H A P. I.

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*Of an Horizontal Dial,* 9

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THE



T H E

Young Gentleman's

D I A L L I N G, &c.



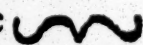
C H A P. I.

*Of D I A L L I N G in general.*



Y (\*) *Dialling* is understood the Art of Shewing the Time of the Day, by the Sun's Shade falling on some Surface, whether Plain or not Plain.

C H A P. I.

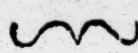
I.   
I.  
Dialling,  
*what.*

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(\*) The Word *Dial* is derived from *Dies*, because thereupon the Time of the *Day* is shewn. And from the peculiar Manner of shewing the Time of the Day upon a Dial, *viz.* by the *Shadow* of the Sun, this Art is frequently termed *Ars Scioterica*, i. e. the *Shadow-Art*, from the Greek Word *σνιξ*, denoting a *Shadow* or *Shade*.



CHAP. Plain Surfaces are most useful, and

I. therefore most used : for which Reasons  
 we will here speak only of *Plain-Dial-*

2. *ling*, i. e. of drawing Dials on Plain  
 Surfaces, simply called *Planes*.

Plain Dial-  
 ling, *what*.

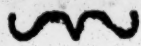
3.  
*The vari-  
 ous Names  
 of Dials,  
 and the  
 Reason of  
 the said  
 Names.*

Every Dial-plane (i. e. plain Sur-  
 face on which a Dial is drawn ) re-  
 presents the Plane of some (\*) Circle  
 in the Heavens. If the Dial-plane  
 represents

---

(\*) This, and the whole Foundation of Dialling, is most naturally, and so most clearly illustrated by the Help of an Instrument or Machine, which may be properly enough called from its Use a *Dialling Sphere*. It need consist but of an *Horizon*, and two ( Wooden or Brasse ) Circles fastened together, crossing each other at Right Angles, and so as to bisect one the other. Either of these Circles may be taken to represent the *Meridian*, and the other the *Equator*. The former is to be divided into four 90 Degrees, and the latter into 360, as in other Spheres or Globes. And in like manner, as in other Spheres, the *Meridian* of this Dialling Sphere must be let into the *Horizon* at the North and South Points of it. There must be a plain Piece of Board to move up and down within the fore-mentioned Circles, so as to represent the Position of any Dial-plane. And through the Center or middle Point of the plain piece of Board, there must be made an Hole, through which, when there is occasion, a String is to be put ; which String being also put through the two Points of the *Meridian*, which are 90 Degrees each from the *Equator*, will represent the Axis of the World. The Dialling Sphere being thus prepared, the Manner how the Sun by the Shade of the Style of the Dial, comes to shew the Time of the Day on any Dial-plane, may be ocularly demon-  
 strated,

represents the Plane of the *Horizon*, CHAP. I.  
the Dial is called an *Horizontal* Dial.

If the Dial-plane represents the Plane  of the Prime Vertical, then the Dial is called an *Erect Direct North* or *South* Dial, respectively as the Dial is drawn on the north or south Side of the said Dial-plane. If the Dial-plane represents the Plane of the *Meridian*, the Dial is called an *Erect Direct East* or *West* Dial, respectively as the Dial is drawn on the east or west Side of such a Dial-plane. If the Dial-plane represents the Plane of any other Vertical Circle, besides the Prime Vertical and *Meridian*, then the Dial is called a *Declining* Dial; forasmuch as it does not directly face any one of the four Cardinal Points of the Heavens, but declines

---

strated, by moving the *Meridian* of the Dialling Sphere, that the String representing the Axis may have such a Position as duly answers to the Latitude of the Dial; and by placing the plain Piece of Board in such a Position as to answer (the Plane of that Circle in the Heavens, which is represented by the Dial-plane; or in short, to answer) the Position of the Dial-plane. Then a Candle duly moved round the String in Imitation of the Sun's Motion, will shew by the Shade of the String, how the Shade of the Dial-Style by the Motion of the Sun, shews the Time of the Day on the Dial-plane.

CHAP. more or less from them. Lastly, if  
 I. the Dial-plane represents the Plane of  
 any greater Circle in the Heavens,  
 besides some Vertical Circle or the  
*Horizon*, then the Dial is called (not  
 an Erect, but) an (\*) *Inclining* or *Re-*  
*clining* Dial, respectively as it is  
 drawn, either on that Side of the  
 Dial-plane, which inclines (or leans  
 forward) towards the *Horizon*; or on  
 the other Side, which reclines (or  
 leans backward) from the *Zenith*.  
 And amongst these are the (†) *Equi-*

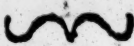
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(\*) These are subdivided into *Direct* Incliners or  
 Recliners, and *Declining* Incliners or Recliners.

(†) The *Equinoctial* Dial is Erect in respect of those  
 who live exactly under the Celestial *Equator*; and like-  
 wise the *Polar* Dial is Erect to such as live (if any there  
 be) exactly under either of the two Poles of the World.  
 For in respect of the former Inhabitants, the Plane of the  
*Equinoctial*, and of the Prime Vertical are one and the  
 same; and in respect of the latter Inhabitants, the Plane  
 of the Prime Vertical, and the Plane of the Circle re-  
 presented by the Plane of a *Polar* Dial is one and the  
 same. Again, the *Equinoctial* Plane is the same with the  
*Horizontal* Plane, in respect to those that are under the  
 Poles; and the *Polar* Plane is the same with the *Hori-*  
*zontal* Plane, in respect of those that live under the *E-*  
*quator*. And the like Change is to be conceived in re-  
 spect of other Dial-planes, as they regard several places;  
 every Dial-plane being an *Horizontal* Plane at some Place,  
 and on the other Side every *Horizontal* Plane being a  
 prime Vertical, and *Meridian* (&c.) Plane at some o-  
 ther Places.

*noctial*

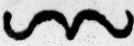


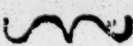
*noctial* and *Polar* Dials. The *Equi-CHAP.*  
*noctial* Dial is so called, as being I.  
 drawn on a Plane, that represents the   
 Plane of the *Equinoctial*. The *Polar*  
 Dial is so called, as being drawn on  
 a Plane, that represents the Plane of  
 that Circle, which passes through the  
 Poles of the World, and also (the In-  
 tersection of the *Equator*, and the  
*Horizon* at the east and west Points,  
*i. e.* in short) the Poles of the *Meri-*  
*dian*.

Among the several Sorts of Dials  
 afore-mentioned, the *Equinoctial* Dial <sup>4.</sup> *of the E-*  
 is the most easy to be drawn; this *quinoctial*  
 being done only by drawing a Circle, *Dial.*  
 and dividing it into twenty-four equal  
 Parts, (to which right Lines drawn  
 from the Center of the Circle, will  
 represent the several Hour-Lines,) and  
 erecting perpendicularly a Pin in the  
 Center of the Circle for the Style.  
 But because (\*) the *Equinoctial* Dial,  
 when thus drawn on one Surface of  
 the Plane, will serve only for one

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(\*) The like is to be understood also as to the *Polar*  
 Dial: on which Account it is of lesser Use; and there-  
 fore the Manner of describing it is omitted in this  
 Treatise.

CHAP. Half of the Year, namely, whilst the  
 I. Sun is on one Side of the *Equinoctial*;  
 and therefore to make it serve for the  
 whole Year, it must be doubly drawn,  
*viz.* on the lower as well as upper  
 Side of the Plane; on Account of  
 this and other Inconveniences, the  
*Equinoctial* Dial is seldom used. And  
 therefore it had not been taken No-  
 tice of here, but that the Knowledge  
 thereof is requisite for the Under-  
 standing the Reason of that Method,  
 which (as being the most Natural, and  
 withal easy Method) is principally  
 made Use of in this Treatise, for  
 drawing the other Dials here spoken  
 of. For, as the Reason why the  
 Circle in an *Equinoctial* Dial is divi-  
 ded into twenty-four equal Parts, an-  
 swering to the twenty-four Hours in  
 a *Nuchthemeron*, is because 15 De-  
 grees, which is a 24<sup>th</sup> Part of the  
*Equinoctial* Circle in the Heavens,  
 answer to one Hour's Motion of the  
 Sun; so, because (at the same Time  
 that the Sun is conceived, by the  
 Shade of the Axis of the World, to  
 shew any Hour on the *Equinoctial*  
 Plane, it does also by the same Shade  
 shew, at the Intersection of any other  
 Plane

Plane with the *Equinoctial* Plane, the CHAP.  
 Point of the said other Plane belong- I.  
 ing to the same Hour; or thus, because)   
 the Hour-points of any other Plane are  
 those Points of the said Plane, which  
 fall in with or touch the Hour-Points  
 of the *Equinoctial* Plane, at the com-  
 mon Intersection of the said two Planes;  
 therefore by the Help of the *Equinocti-*  
*al* Dial may be drawn other Dials, name-  
 ly, the *Equinoctial* Dial being duly ap-  
 plied to the Plane given, the Hour-  
 Points of the *Equinoctial* Dial will fall  
 on the correspondent Hour-points of (the  
 Dial to be drawn on the) Plane given.

And this will be distinctly exemplified  
 as to the several Sorts of Dials above-  
 mentioned, (excepting Inclining and  
 Reclining Dials, as being of lesser Use)  
 after that it has been here observed  
 further in general, that the whole Bu-  
 siness of Dialling may be reduced to  
 three general Heads or Operations:  
 Whereof the first consists in finding the  
 Place of the *Substyle*, or where the *Style*  
 is to be placed: the second in drawing  
 the *Hour-Lines*: the third and last, ei-  
 ther, if the Dial-plane be Moveable, in  
 duly Placing and *Fixing* the same, after  
 S that

5.  
 The Busi-  
 ness of  
 Dialling  
 reducible  
 to three  
 Heads or  
 Operations.



CHAP. that the Dial is drawn thereon ; or else,

I. if the Plane whereon the Dial is to be  
~~~~~ drawn, be unmoveable and already fixed, in Finding the *Position* or Situation of the said Plane, *viz.* whether it be a Direct or Declining Plane ; and if the latter, how far it declines.



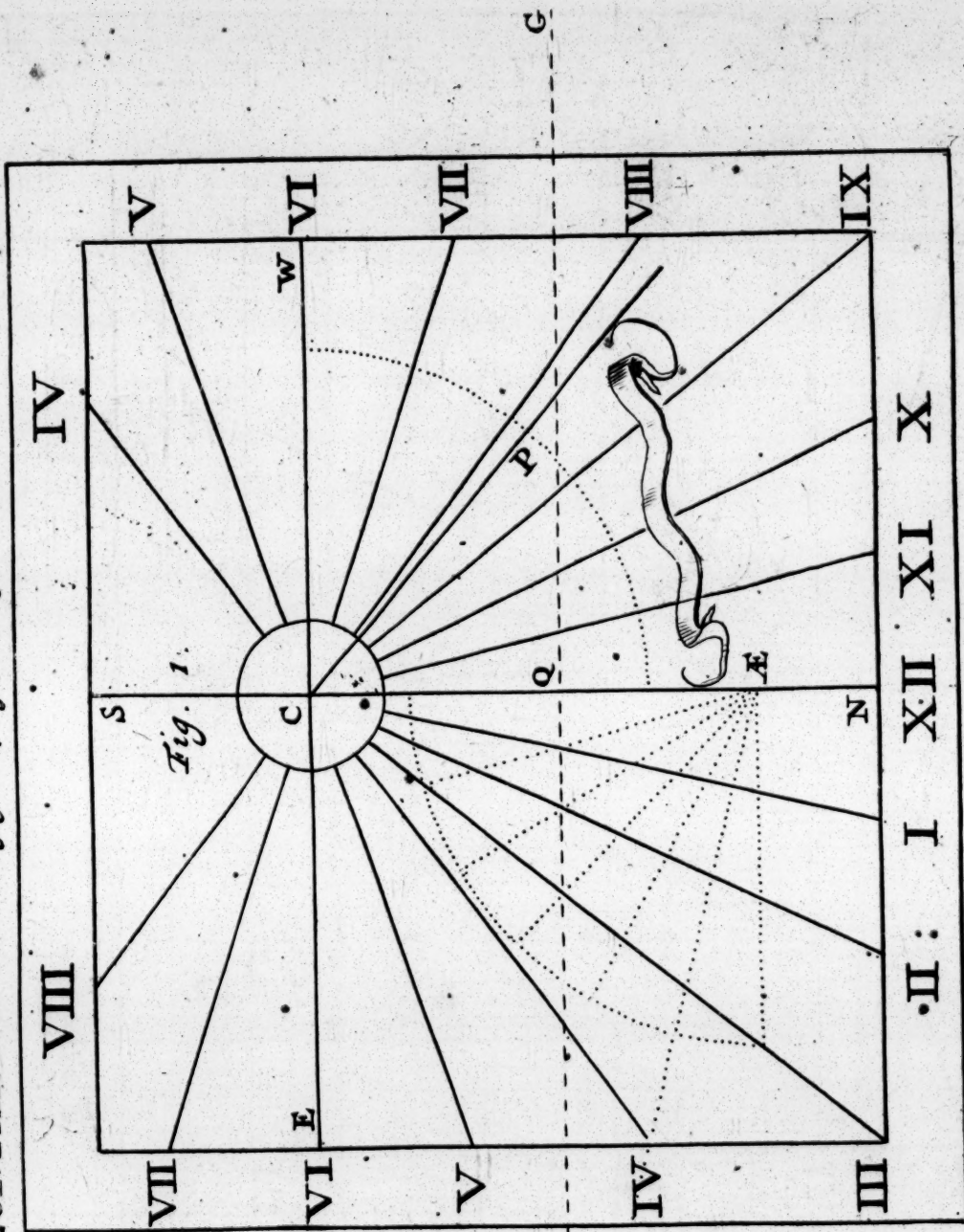
CHAP.

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An HORIZONTAL Dial drawn by y^e help of y^e EQUINOCTIAL Dial.

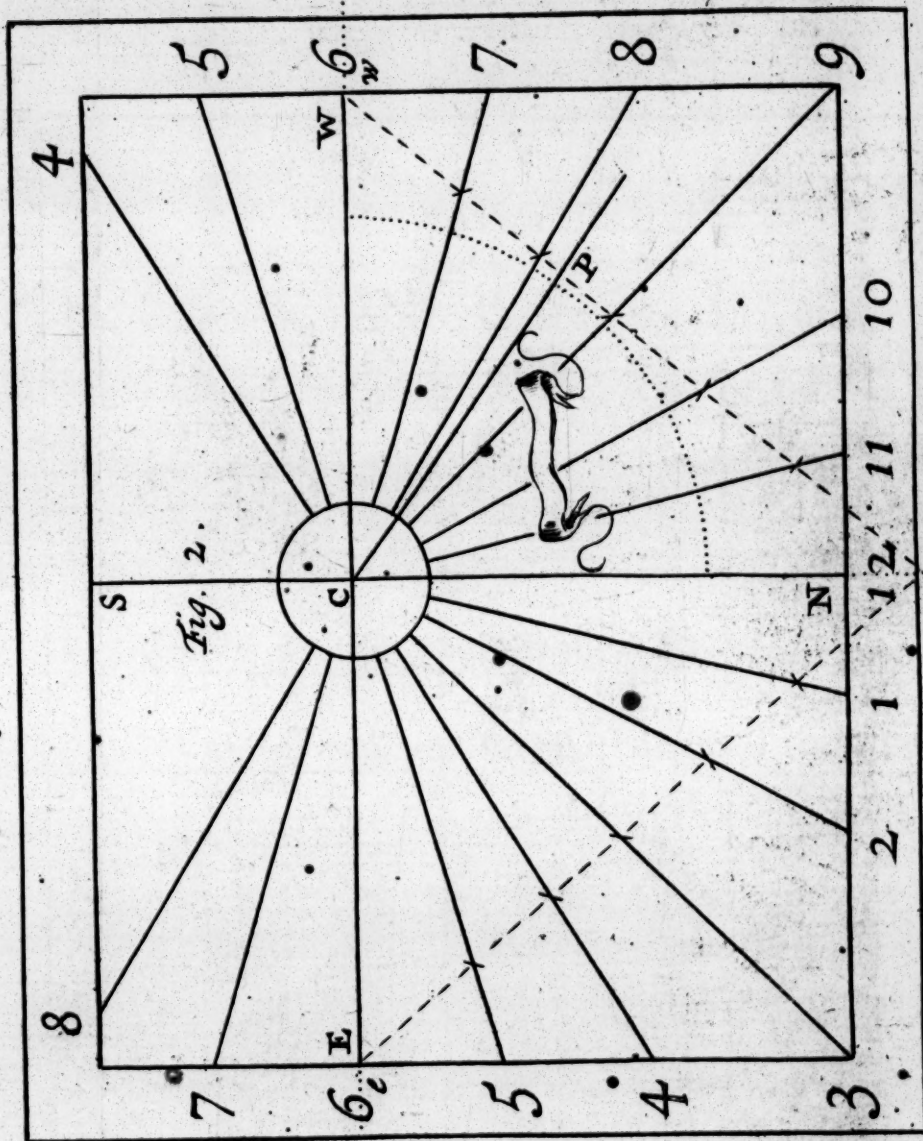
Dial Plate 1.

*Place this
facing p. 9.*

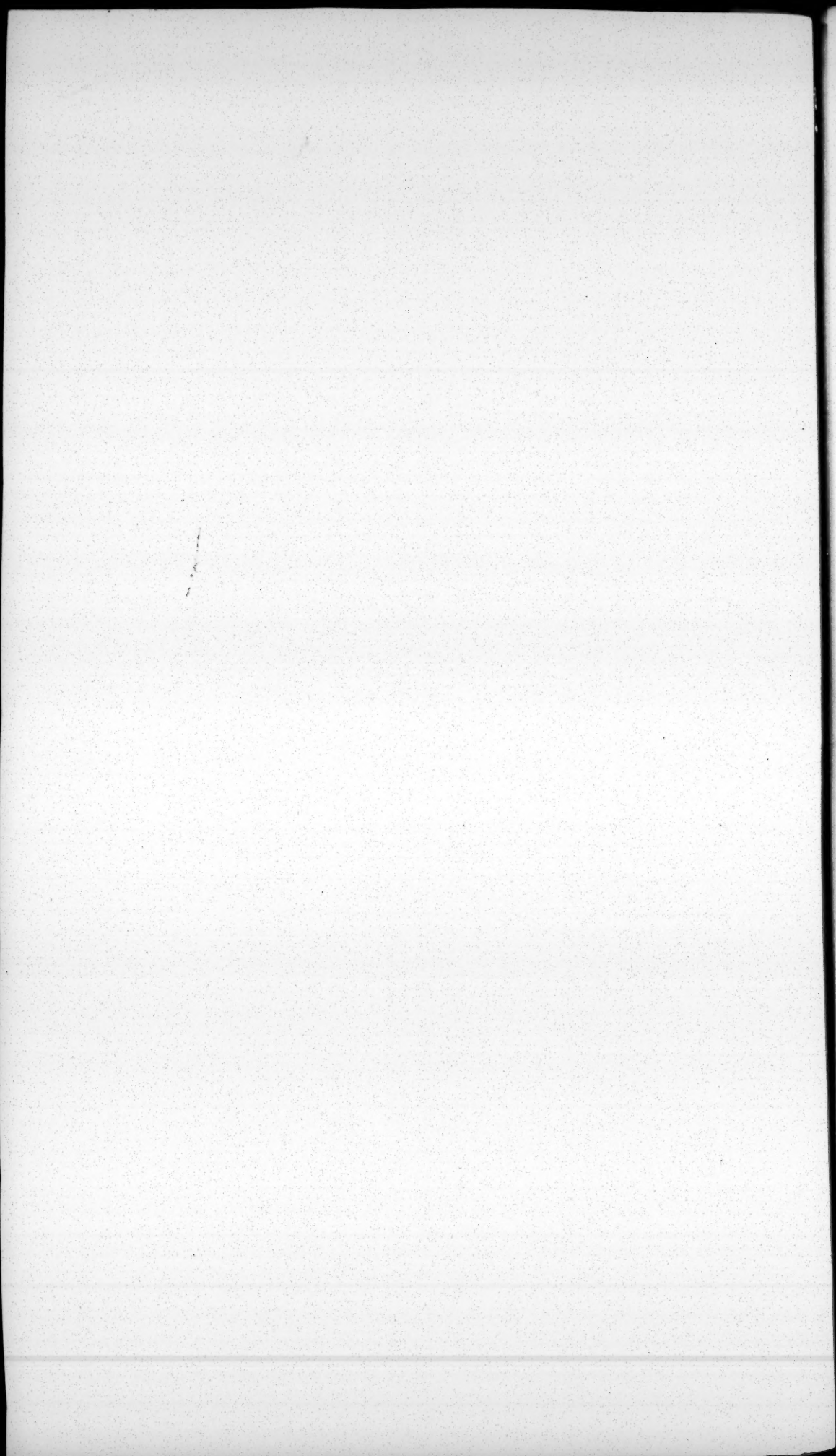


| | | | | | | |
|-----|----|---|-----|----|---|----|
| III | II | I | XII | XI | X | IX |
|-----|----|---|-----|----|---|----|

Place this
facing p. 18.

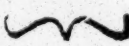


An HORIZONTAL Dial drawn by y help of Dialling Scales.



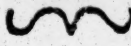
C H A P. II.

Of an HORIZONTAL Dial.

I Begin with the *Horizontal* Dial, as C H A P. II.
 being the most Useful ; forasmuch II.
 as it singly answers the whole (*) End of 
 Dialling, by shewing the Time of the I.
 Day from Sun-rising to Sun-setting The Horizontal
 throughout the whole Year, within that Dial; why
Horizon for which it is made: whereas first spoken
 no other Dial does this. And having of.
 made this Observation as to the Usefulness of the *Horizontal* Dial, we proceed now to the Delineation thereof.

Whereas the four Cardinal Points of 2.
 the Heavens are distant one from the o- To draw
 ther 90 Degrees; and whereas the *Me-* the Meri-
ridian runs from North to South, and dian and
 the prime Vertical runs a-cross the *Me-* Prime
ridian from East to West; hence it fol- Vertical
Lines of an
Horizontal
Dial.

(*) The whole proper End of Dialling is, to shew the Time of the Day by the Sun's Shade. As for shewing the Place of the Sun in the Ecliptick (and the like) by the Shade on a Dial-plane, this does not properly belong to Dialling.

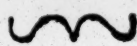
CHAP. lows, that, two right Lines being drawn
 II. crossing one the other at right Angles
 (whose Measure is each 90 Degrees)
 and either of these two right Lines being taken to represent the *Meridian*, the other will represent the Prime Vertical. That taken to represent the *Meridian*, may be fitly denoted by N S, as running in this Dial from North to South; the other by E W, as running from East to West. See *Fig. 1.*

3. The Point, where the Lines N S and E W cross one another, denotes
 The Center of an Horizontal Dial, which (*) that Point in the Plane of the *Horizon*, (as also of the *Meridian* and Prime Vertical) through which the Axis of the World passes. And because the said Point is the (†) Center (of all the said Planes, particularly) of

(*) This may be evidently shewn by the Help of a Dialling Sphere.

(†) The Axis of the World passing through the Center of the World, which is also the Center of all great Circles in the Heavens, and consequently of the *Horizon*, *Meridian*, and Prime Vertical; hence it follows, that That Point in the Planes of the said Circles, through which the Axis of the World passes, must be the Center of the said Planes.

the

the *Horizontal* Plane, whereon the Di- CHAP.
al is to be drawn, and consequently the II.
Center of the Dial it self, hence it 
may be fitly marked or denoted by C,
as *Fig. 1.*

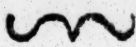
The Axis of the World being the (*) 4.
common Interfection of the Planes of all ^{Of the}
Meridians, and therefore running from ^{Substyle}
Pole to Pole along the Plane of every ^{and Style.}
Meridian; hence the Line N S repre-
senting the Plane of the *Meridian* of
that Place, for which the Dial is made,
must be the *Substyle*, or the Line
whereon the (†) *Style*, which repre-
sents the Axis of the World is to be
(||) erected.

(*) This may also be evidently shewn by the Help of
the Dialling Sphere.

(†) It is so called, because it needs be, and often actu-
ally is, no more than a long straight Iron Pin, like an
Engraving or old Sort of writing Pin, called a *Style*. It
is called also by a *Latin* Word, the *Index*, because it tells
or *shews* what is the Time of the Day. And it is called
likewise by a *Greek* Word the *Gnomon*, (from γνῶω to know)
because thereby is *known* the Time of the Day.

(||) By being *erected* is understood here, and all along
this Tract of Dialling, being placed *perpendicularly* upon
the *Substyle*, so as not to lean any thing more towards the
Hour-lines on one Side of the *Substyle*, than towards
the Hour-lines on the other Side of the *Substyle*.

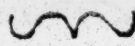
CHAP. And because the Style does represent

II. the Axis of the World, therefore it
 must be so erected upon the Substyle,
 (which is the common Intersection of
 the *Horizontal* and *Meridian* Planes)
 as therewith to make an Angle equal
 to the Elevation of the respective
 (North or South) Pole above the *Ho-*
riзон of the Place, or (which comes
 to the same) to the (*) Latitude of
 the Place. Wherefore taking C for
 the Center, draw (†) an Arch of a
 Circle from N S (on either Side) to
 E W. On the said Arch (||) set off from
 N S towards E W, (*viz.* at P. Fig. 1.)
 so

(*) How the Elevation of the Pole and Latitude of the Place come to be always Equal, may be evidently shewn on the Globe.

(†) This Arch may be drawn, at what Extent of the Compasses or Distance from the Center you please ; but it is convenient to have regard to the Largeness of the designed Dial. And also it is convenient to make Use of a *Line of Chords*, in this, and all such Operations, in Order to the setting off on the Arch drawn any Number of Degrees, with much more Ease and Readiness than can be done otherwise. The Reader is here supposed to be already instructed in the Use of the Line of Chords.

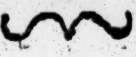
(||) That is, the Style, if it be only a long straight Piece of Iron, must be so placed on the Substyle of the Dial, as to have the same Inclination thereto, as CP
 has

so many Degrees as answer to the Ele-
vation of the Pole; for Instance (*Fig.*
1.) $51\frac{1}{2}$ the Latitude of *London* or 
Elevation of the north Pole there. The
Line CP being drawn will shew the
Style.

Having found the Substyle NS, 5.
and the Style CP, draw a long Line *Of the*
crossing the Substyle in any Point, *Conti-*
(which shall seem most convenient,) *gent Line,*
suppose Q, at right Angles. This Line *and apply-*
representing the common Interfection of *ing the E-*
the *Equinoctial* Plane and Dial Plane, *quinoctial*
is therefore called the (*) *Contingent* *Dial to the*
Line, and is denoted (*Fig.* 1.) by the *Plane of*
Line TG. That Point in the Substyle, *your Ho-*
which is so far distant from Q, as the *rizontal,*
Point Q is found by the Compasses to *Dial.*
be distant from the nearest Point of the
Style, represents the Center of the *E-*
quator, or that Point from which an
Equinoctial Dial is to be delineated on

has to NS. If you would have the Style a broad Plate
of Iron or the like, then it must be made exactly equal
to the Triangle NCP. In both Cases, the lower Point
of the Style, namely, wherein the Lines CN and PN
meet, must be placed exactly on C, as being the Point
of the *Horizontal* Plane, through which passes the Axis,
represented by the Style.

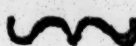
(*) It is so called, because herein the two Planes are
conceived to *touch one another*.

CHAP. the Dial-plane, and therefore it may fit-
 II. ly be marked $\text{\AA}$. Taking then $\text{\AA}$ for
 the Center, at (*) any Distance, draw
 toward the Contingent a (+) Semicircle
 representing half the *Equinoctial*, so as
 that one Half of the Semicircle (*i. e.*
 fourth Part of the *Equinoctial*) may be
 on each Side of the Substyle. Then di-
 vide the said Semicircle into twelve equal
 Parts, (*viz.* six on each Side of the Sub-
 style,) each containing an Arch of 15
 Degrees, (||) Lines drawn from $\text{\AA}$ the
 Center of the *Equinoctial* to each Divi-
 sion of the Semicircle will be the Hour-
 Lines of the *Equinoctial* Plane or Dial;
 among

(*) However it is convenient to be guided herein by
 the Length of the Line of Chords made use of, and by
 the Size of the intended Dial.

(+) This may be otherwise done by only drawing one
 Halt of this Semicircle on one Side of the Substyle, and
 dividing it into six equal Parts; and thence transferring
 the said six Divisions to that Part of the Contingent,
 which is on the other Side of the Substyle. And this is the
 best Way for practice, being shorter, and not cumbring
 the Work with Multitude of Lines. And 'tis adviseable
 to draw the said Quadrant, or fourth Part of the *Equi-
 noctial* Circle or Dial on that Side of the Substyle, where
 the Style is not drawn: because then the *Equinoctial* Di-
 al and the Style will stand both clear one from the other;
 as in the Figures hereunto belonging.

(||) These, and all other Lines or Circles or Arches
 of Circles are to be *obscure* ones, *i. e.* such as may be
 rubbed out again, excepting only the proper Hour-
 lines

among which Hour Lines, the Substyle CHAP. and Meridian NS of the Horizontal II. Dial will also be the Meridian of the  Equinoctial Dial.

Having thus fitted the Equinoctial 6. Dial to the Horizontal Plane, on which ^{To draw the Hour-lines of an Horizontal Dial.} the Horizontal Dial is to be drawn, it will be very easy to find the Hour-points of the said Horizontal Dial: namely, by continuing the Equinoctial Hour-lines to the Contingent, and thereby seeing on what Points of the Horizontal Plane the Hour-lines of the Equinoctial Plane will fall. For the said Points of the Horizontal Plane are respectively the Points, on which the correspondent Hour-lines of the Horizontal Dial will fall, being drawn from (*) C the Center of the Horizontal Dial. Among these Hour-lines, the Line NS being both the Meridian and Substyle of the Horizontal Dial, (and so falling in with the Meridian of the Equinoctial Dial) will therefore be the twelve a Clock

lines in each Dial. These obscure Lines are distinguished in the Draughts hereunto belonging by being made *prick'd* Lines.

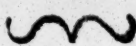
(*) The Hour-lines represent the Shade conceived to be made by the Axis of the World; which Axis being

CHAP. II. Clock Line of the *Horizontal* (as well as *Equinoctial*) Dial. Which being known, the Numbers 11, 10, 9, 8, and 7, are to be affixed to the Hour-lines on the west Side of the Dial, according to their respective Order from the twelve a Clock Line. And in like manner the Numbers 1, 2, 3, 4, and 5, are to be set to the respective Hour-line on the east Side of the Dial. The Line EW, as representing the Prime Vertical, is always the 6 a Clock Line, both Morning and Evening. And as for the Hours before six in the Morning, and after six in the Evening, their Lines are drawn by continuing the Lines of those Hours, which are of the same Denomination in the contrary Part of the Day, through the Center C of the Dial. Thus the

being conceived to pass through C the Center of the Dial, hence all the Hour-lines must be drawn from the said Center. Only it is observable, that it is more Ornamental, not to draw actually the Hour-lines from C (because if they were so drawn, they would be apt to run together, and blot at the point C,) but making a Circle at some small distance from C, actually to draw the Hour-lines only from the said Circle, by the Ruler duly applied to C, as *Fig. 1.* 'Tis also observable, that the Dial-plane may be of any Shape, *viz.* Round or Triangular, &c. as well as Square or Oblong, though this Shape is most used among us.

Hour-

Hour-lines of 5 and 4 in the Morning are CHAP.
drawn, by continuing the Hour-lines of II.

5 and 4 in the Afternoon through C. 
And the Hour-lines of 7 and 8 in the
Evening are drawn, by continuing the
Hour-lines of 7 and 8 in the Morning
through C. And thus the Delineation
of an *Horizontal* Dial is finished, (as is
represented, *Fig. 1.*) according to the
Method of Delineating the same by the
Help of an *Equinoctial* Dial. For as to
the intermediate Spaces between each
Hour, (*viz.* Quarter, Half, and three
Quarters,) they are had by dividing the
Space between each two Hours, first into
Half, and each Half again into Quarters.

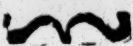
It may not be unuseful (not only for 7.
Variety, (*) but also Proof sake) to add *To draw
an Hori-
zontal Dial
by a Dial-
ling Scale.*
here the Method of drawing an *Hori-
zontal* Dial, by Dialling Scales and Ta-
bles. The former is thus: The Lines
NS and EW being drawn and the

(*) If you have drawn your Dials right, the same
Hour-lines, at equal Distance from the Center of your
Dial, will be equally distant also one from the other, by
which Method soever you draw them, *v. g.* The Di-
stance between 12 and 1, (or 12 and 2, or 1 and 2,
&c.) will be the same, at equal Distance from the Cen-
ter of your Dial, whether it be drawn by the *Equinoctial*
Dial, or by Scales, or by Tables.

Style

CHAP. Style CP erected, as afore ; the Length
 II. of the Line EW is to be determined, so
 as to bear a due Proportion to the Scale
 of Hours you are to Use. This is done
 by placing one Foot of the Compasses at
 the Beginning of the Scale of *Latitudes*,
 (contained in the Dialling Scale,) and
 opening the other Foot, till it reaches
 to the Number of Degrees in the said
 Scale of Latitude, which answers to the
 Latitude of the Place. This Extent is
 to be set off on the Line EW, from C
 towards E, and also toward W ; and
 where it ends, it may be respectively
 marked *e*, *w*, as *Fig. 2*. Then out of
 the Dialling Scale take the whole Length
 of the Scale of *Hours*, with the Com-
 passes ; and setting one Foot of the
 Compasses in *e*, with the other make an
 Arch crossing the Line NS towards N ;
 and then do the like on *w*. From the
 Point *x* of the Line NS, where the two
 Arches (*) cross one another, draw the

(*) If the Lines drawn by the Compasses, set upon *e*
 and *w*, do not cross one the other exactly in some
 Point of the *Meridian* NS, then some Fault has been
 made in setting off the said Lines, and the Work must
 be repeated, till they do thus cross.

Lines xe and xw ; which will be of CHAP. II.
 an equal Length with the Scale of Hours in the Dialling Scale: from which Hour-
 scale the several Hours (and the intermediate Spaces) are to be respectively transferred unto the Lines xe and xw . Lines drawn from C to the several Hour-points on the Lines xe and cw , will be the respective Hour-lines. And so the Dial is finished by the Scale: for the Hour-lines before 6 in the Morning, and after 6 in the Evening, are to be had, as afore.

If you would work by Dialling Ta- 8.
 bles, having drawn the Lines NS and E W to what Length you please, upon C the Intersection of the said Lines draw a Semicircle esw , as in *Fig. 3.* To draw an Horizontal Dial by Dialling Tables.
 Then on the said Semicircle set off the Degrees and Minutes answering to each Hour (and each Quarter, Half, or three Quarters of an Hour) in the Table for *Horizontal Dials*. After which draw the Hour-lines from C to the several Hour-points in the said Semicircle. The Substyle and Style are found, as afore.

Having

CHAP. Having shewn, how to draw an Ho-
II. *rizontal* Dial three several Ways, it re-
mains now to shew how to *place aright*
the said Dial, when drawn, and this
will be best spoken of together with the
placing of other Dials, *Chap. 5.*



CHAP.

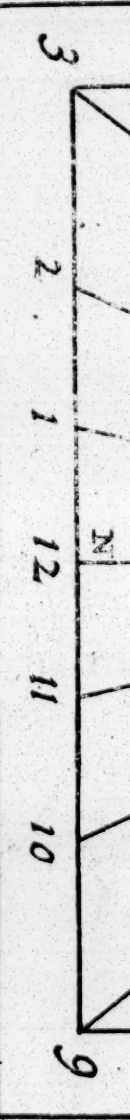
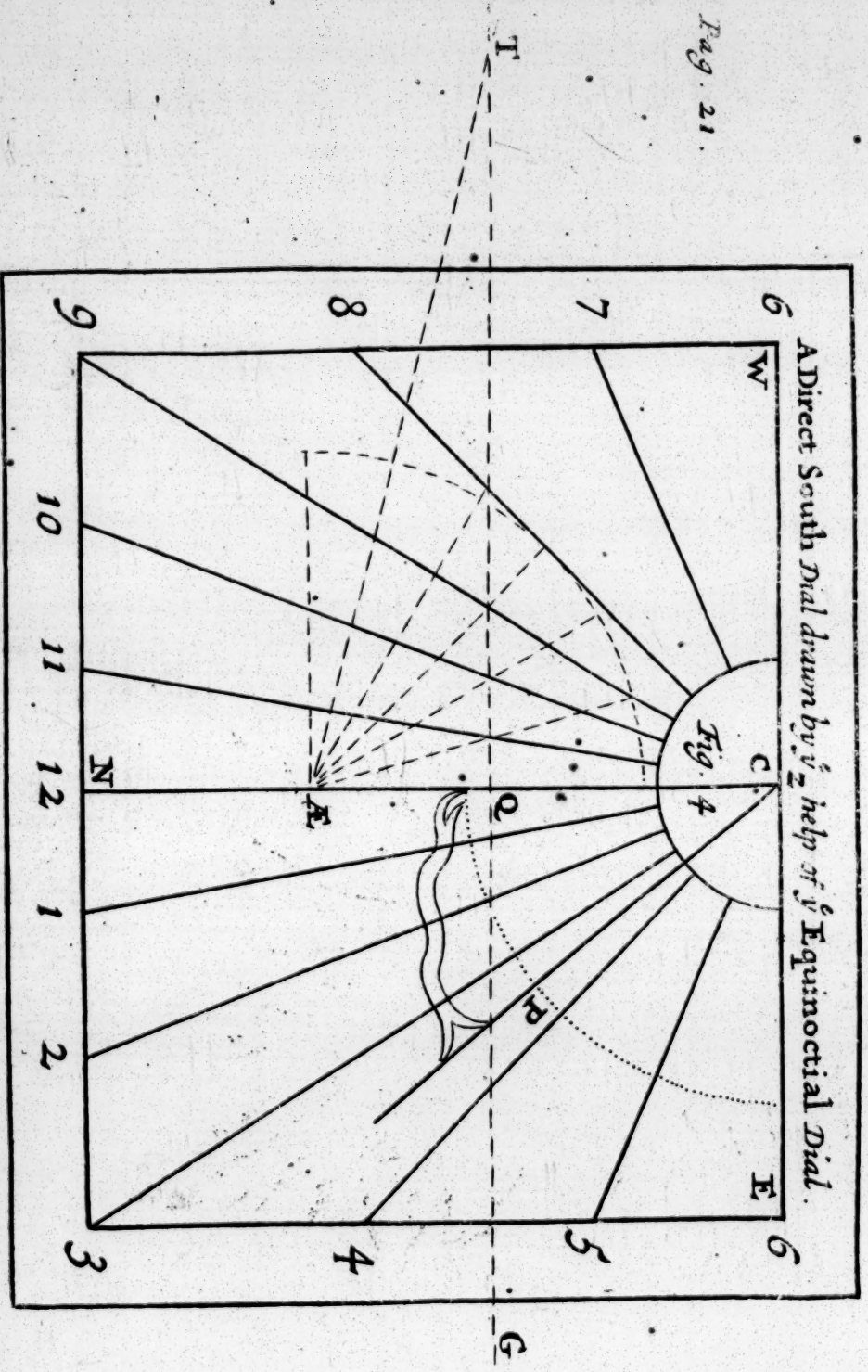
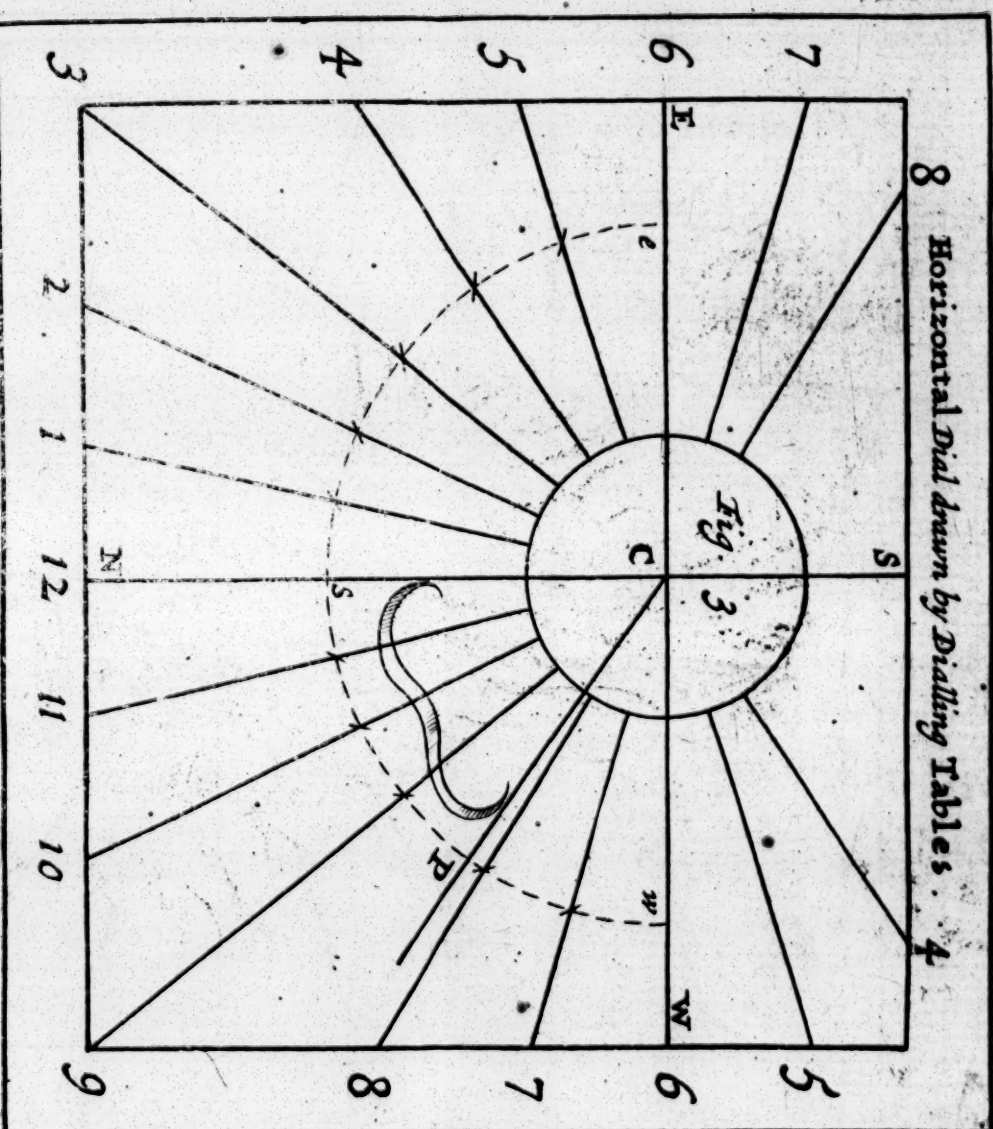


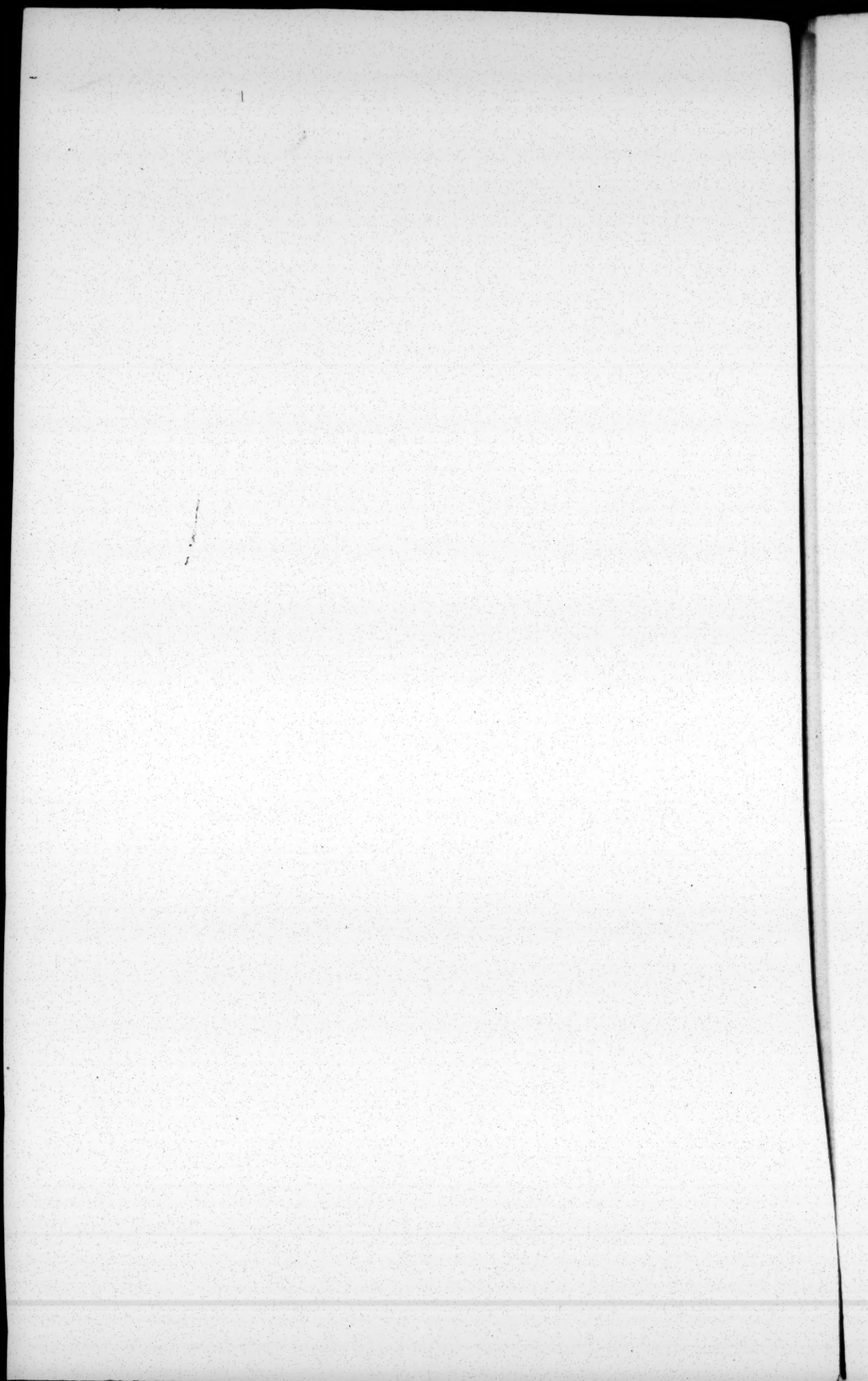
Fig. 21.



Dial. Plate 2.

Place this facing
pag. 20.





C H A P. III.

Of an (*) *Erect Direct South and North* D I A L.

TH E *Erect Direct South* Dial shall be spoken of next, as being next to the *Horizontal* Dial the most useful: forasmuch as it shews the Time of the Day from 6 to 6 throughout the whole Year.

This Sort of Dial is drawn after the same manner, by the Help of the *Equinoctial*, as the *Horizontal* Dial, excepting the Particulars following; viz. First, That the *Meridian* or 12 a Clock Line, (which in this, as well as the *Horizontal* Dial, is always the Substyle,) forasmuch as it must be so placed as that one of its Ends must Point to the (†) *Zenith*, the other to the

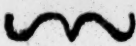
C H A P. III.

I. A Direct South Dial the most useful next to an Horizontal Dial.

2. To draw a Direct South Dial, by the Help of the Equinoctial Dial.

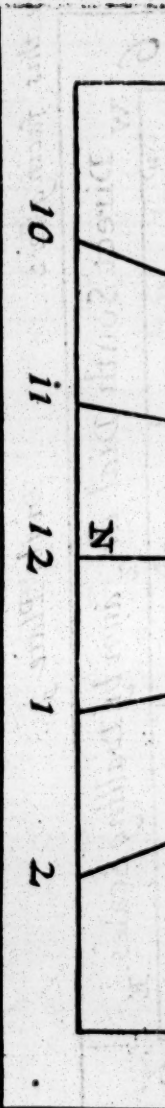
(*) Inclining and Reclining Dials being seldom used, hence these Dials are frequently styled only *Direct South* and *North* Dials.

(†) The *Meridian* of any Place or Dial, as it passes through the North and South Poles, so it passes likewise

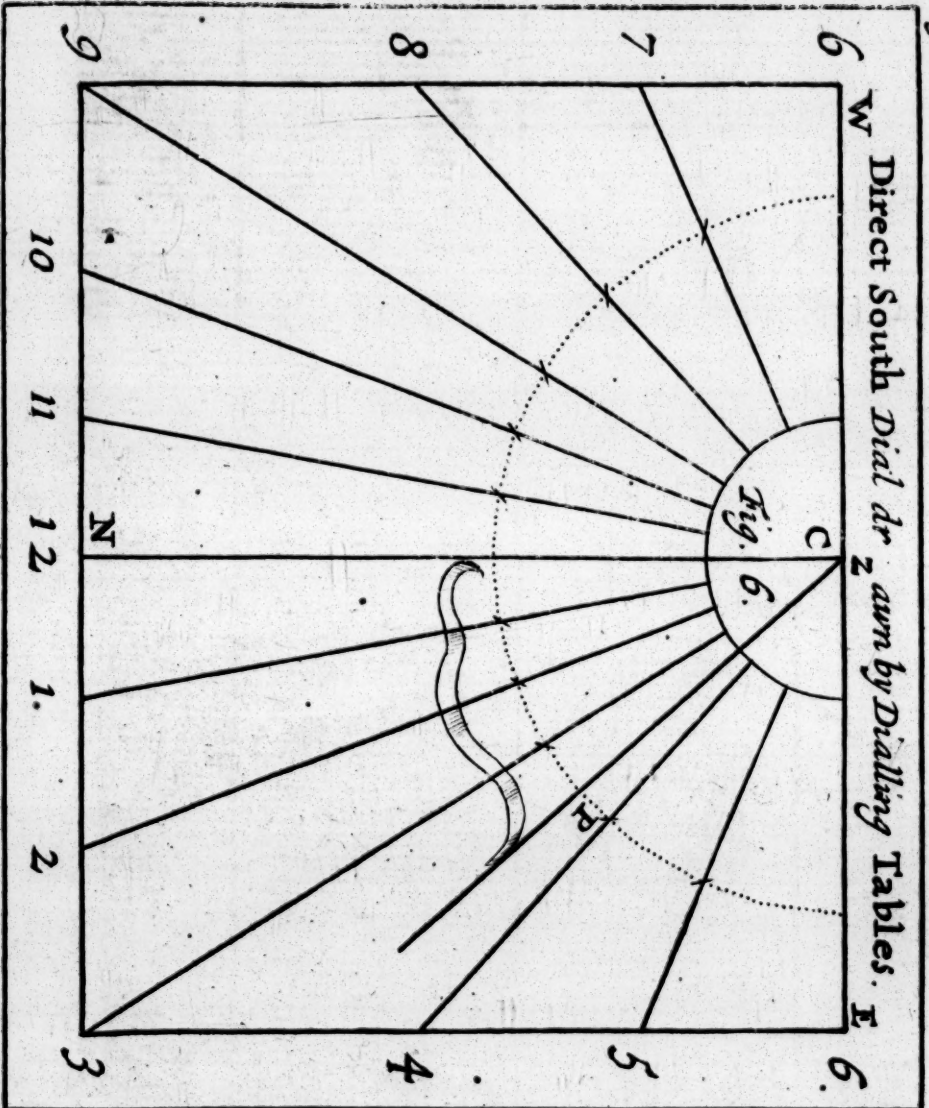
CHAP. the *Nadir*, may therefore be most
 III. properly here denoted by ZN. *Se-*
 *condly*, the Style CP must be erected
 upon the Substyle ZN, so as to make
 therewith an Angle equal (not to the
 Elevation of the Pole, as in an *Hori-*
zontal Dial; but) to the Complement
 of the Pole's Elevation. For such is
 the Measure of the Angle, which the
 (*) South Pole, represented by the
 Style of this Dial, makes with the
 Plane of the Prime Vertical. Now
 the Elevation of the Pole above the
Horizon of *London* being $51\frac{1}{2}$ De-
 grees, its Complement is $38\frac{1}{2}$ De-
 grees: *Thirdly*, On this Dial there
 need be inscribed no Hour, either be-
 fore 6 in the Morning, or after 6 in
 the Evening: for the Plane of this

wise through the *Zenith* and *Nadir* of the said Place.
 In an *Horizontal* Dial the *Meridian* Line is to be placed
 with its Ends towards the North and South Points, and
 therefore is therein fitly denoted by NS: But in a Direct
 South Dial, the *Meridian* Line is to be placed so, as that
 its Ends may Point to the *Zenith* and *Nadir*, and there-
 fore is here more fitly denoted by ZN.

(*) This may be evidently represented to the very
 Eye by the Dialling Sphere; and consequently the Rea-
 son why the End P of this Style must be placed down-
 wards.

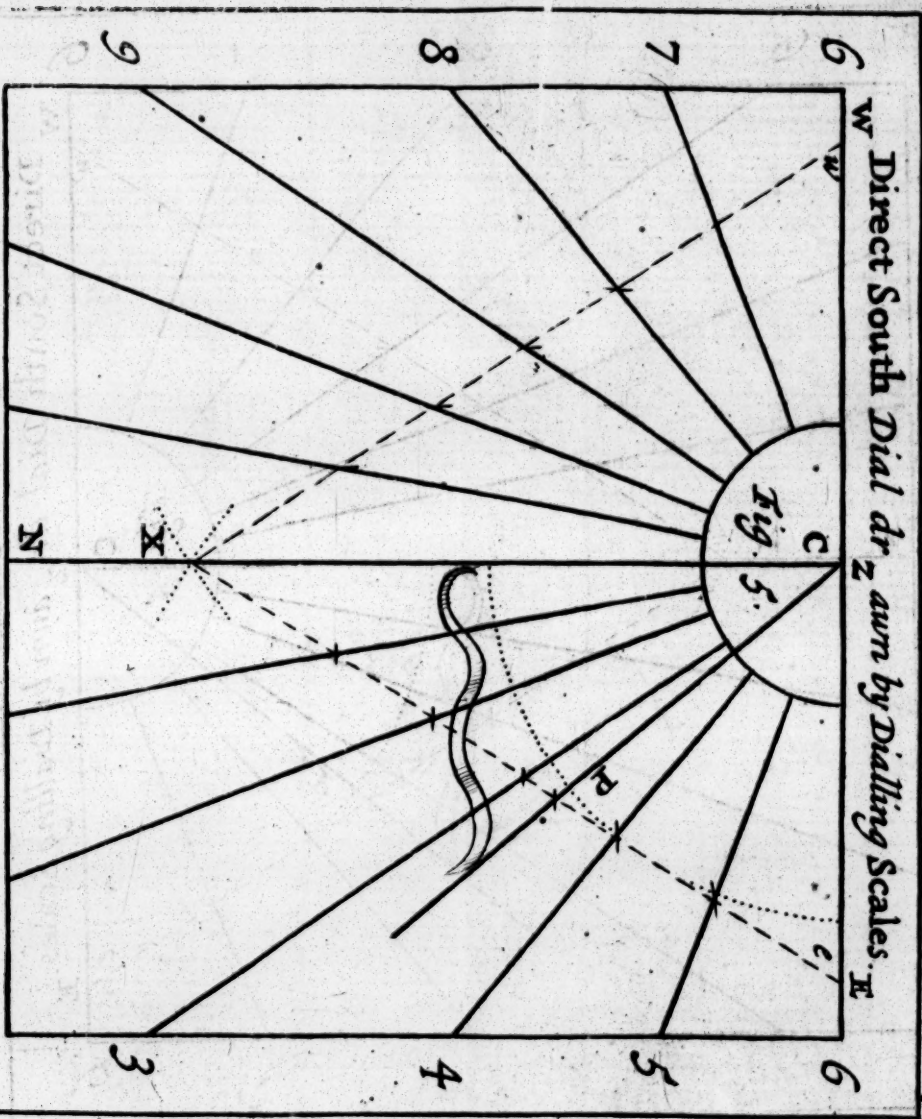


23.



Place this facing p. 22.

Dial. Plate 3

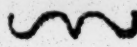


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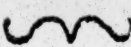
a
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n
V
S

Dial representing the south Side of the CHAP.
Plane of the Prime Vertical, the Sun III.
never shines upon it before 6 in the Morning, or after 6 in the Evening. 
See Fig. 4.

If you work (not by the *Equinoctial* 3.
Circle or Dial, but) by a Dialling Scale, To draw a
Direct
South
Dial by a
Dialling
Scale.
then (besides the fore-mentioned Particulars, wherein the drawing of this Dial differs from drawing an *Horizontal* Dial) it is also to be known, that upon the Line E W, from C towards E and W, must be set off the Extent (taken from the Scale of Latitude; not of the Latitude it self, but) of the Complement of the Place's Latitude.
See Fig. 5.

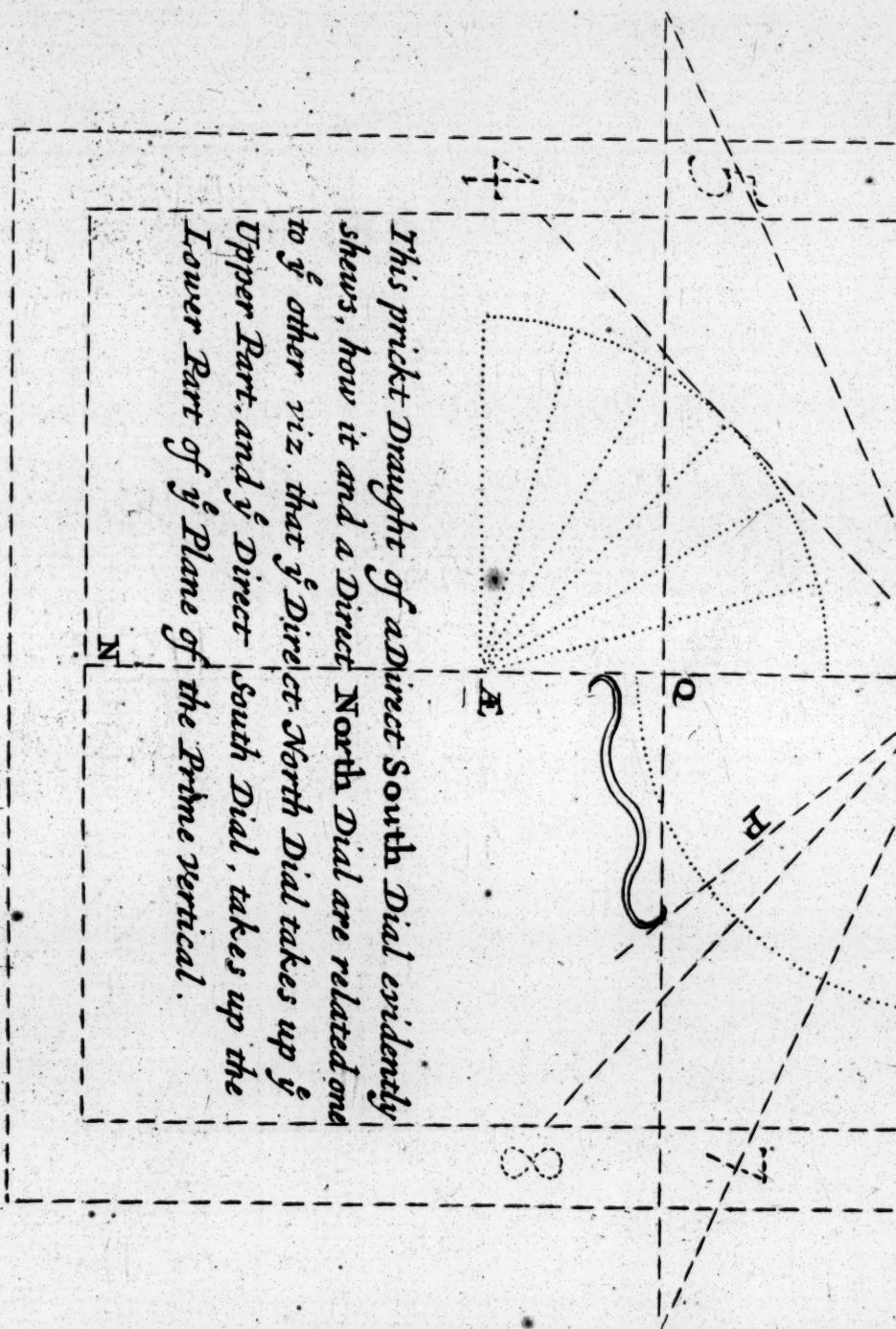
If you work by Tables, then the Degrees of the Angle, which every Hour-line makes with ZN the *Meridian* or 4.
To draw
the same
by Dialling
Tables.
Substyle, must be taken from the Table for a Prime Vertical or Direct South Dial. See Fig. 6.

A Direct North Dial differing from a Direct South Dial primarily in this 5.
To draw a
Direct
North
Dial.
alone, that the former represents the north Side of the Plane of the Prime Vertical, and the latter the south Side; hence the drawing of a Direct
T North

CHAP. North Dial is the same, as of a Direct South Dial; excepting 1st, that  the Hours requisite to be inscribed on this Dial in our Country are no more than these, *viz.* 4, 5, 6, in the Morning, and 6, 7, 8, in the Evening. For the Sun with us never rises till after 3 in the Morning, and always sets before 9 in the Evening; and from 6 in the Morning till 6 in the Evening it turns off from the North to the South Side of the Plane of the Prime Vertical. 2^{dly}, Forasmuch as the Style of this Dial represents the north Segment of the Axis, and so its End P represents the North Pole, therefore the End P must be placed looking upwards toward the North Pole. And consequently that End of the Substyle, which answers to the End P of the Style, must Point towards the *Zenith*, and therefore is here properly to be denoted by Z, and the other End of the Substyle by N, as answering to the *Nadir*, contrary to the Position and Notation of them in a Direct South Dial. See *Fig. 7.*

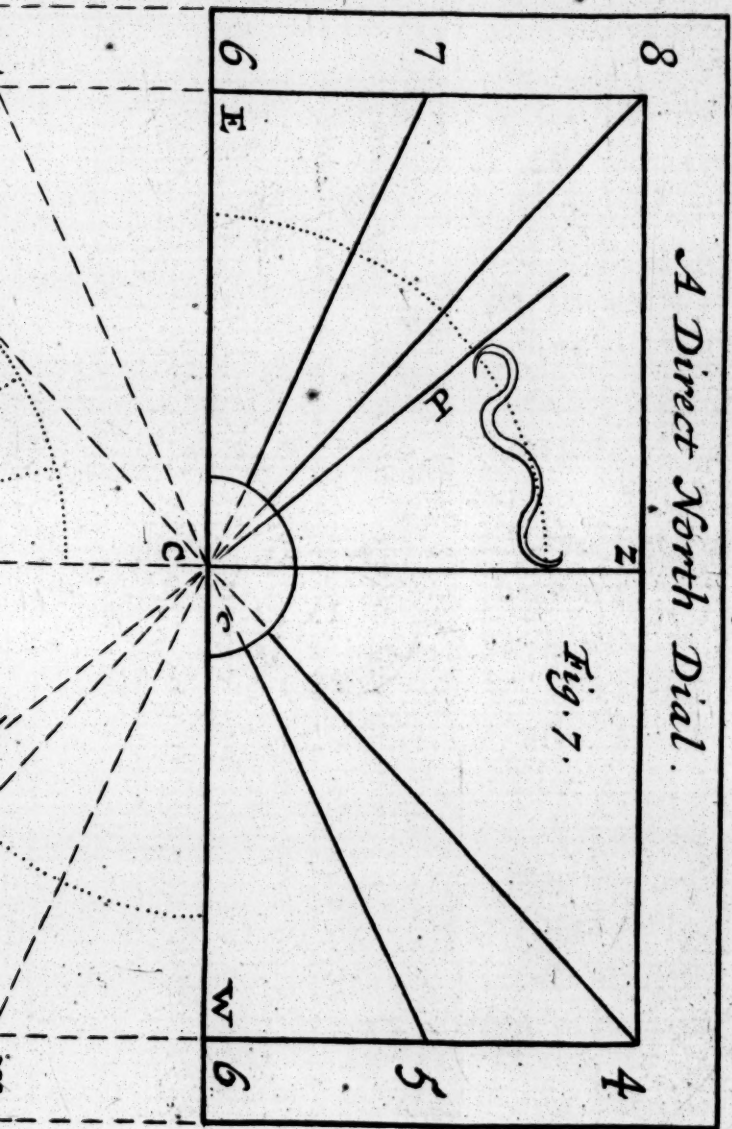
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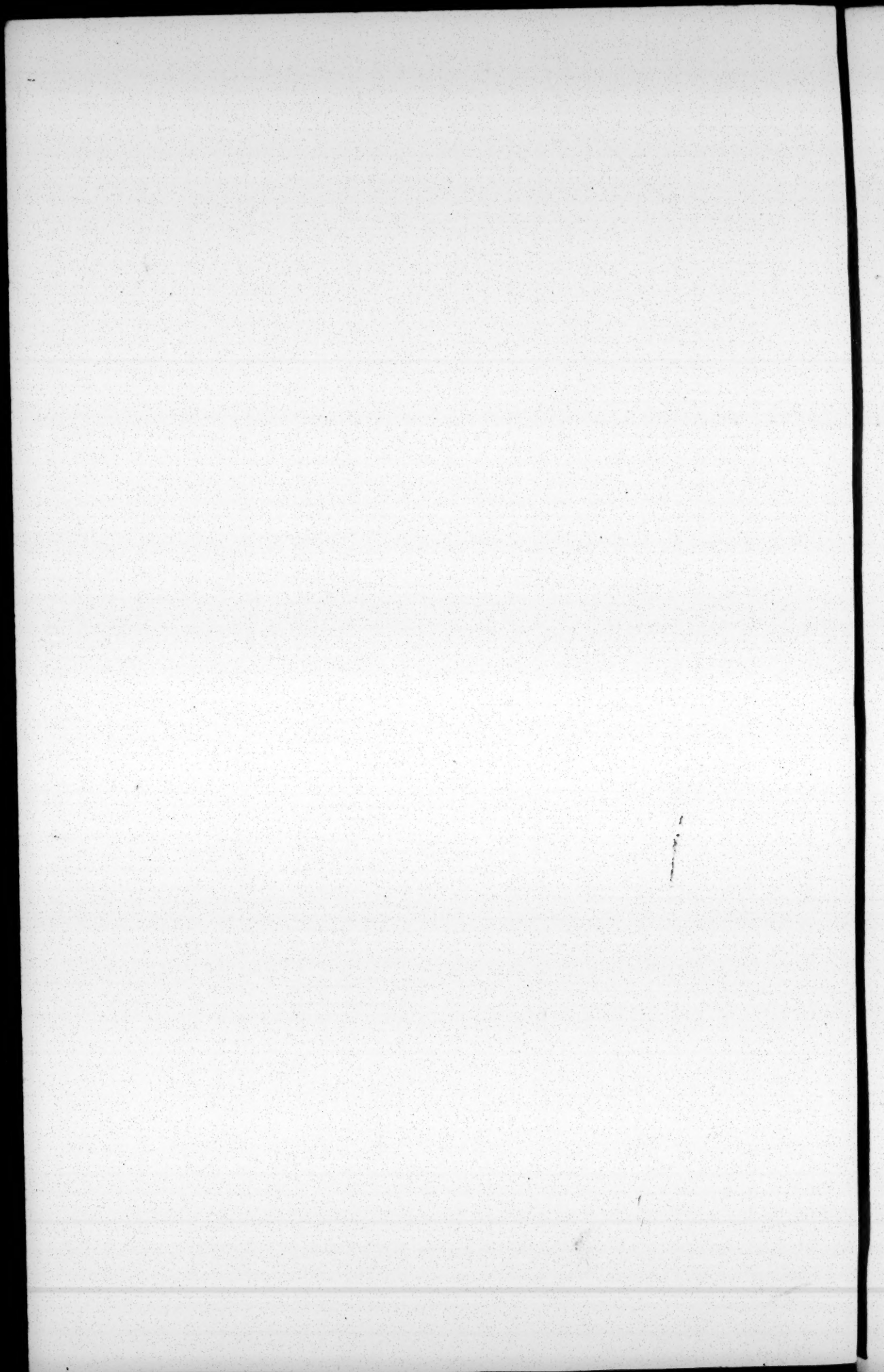
This prick Draught of a Direct South Dial evidently shews, how it and a Direct North Dial are related one to y^e other viz. that y^e Direct North Dial takes up y^e Upper Part, and y^e Direct South Dial, takes up the Lower Part of y^e Plane of the Prime Vertical.



Dial. Plate 4.

A Direct North Dial.





Of a Direct North DIAL. 25

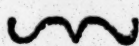
As to the Placing of a Direct CHAP.
South or North Dial, it will be III.
more conveniently spoken of *Chap.* 5.



C H A P. IV.

Of an (*) *Erect Direct East or West*
D I A L.

CHAP. IV. **I** Begin with a *Direct East* Dial, whose Plane represents the east Side of the Plane of the *Meridian*. Now

 1. *To draw a Direct East Dial.* to draw this Dial, there must be first drawn an *Horizontal* Line, *i. e.* a Line representing the *Horizon*, or running Parallel to it, and so level. One End of this Line will represent the north Point of the *Horizon*, and may therefore be fitly denoted by N; and the other End by S, as representing the south Point of the *Horizon*. See *Fig. 8.*

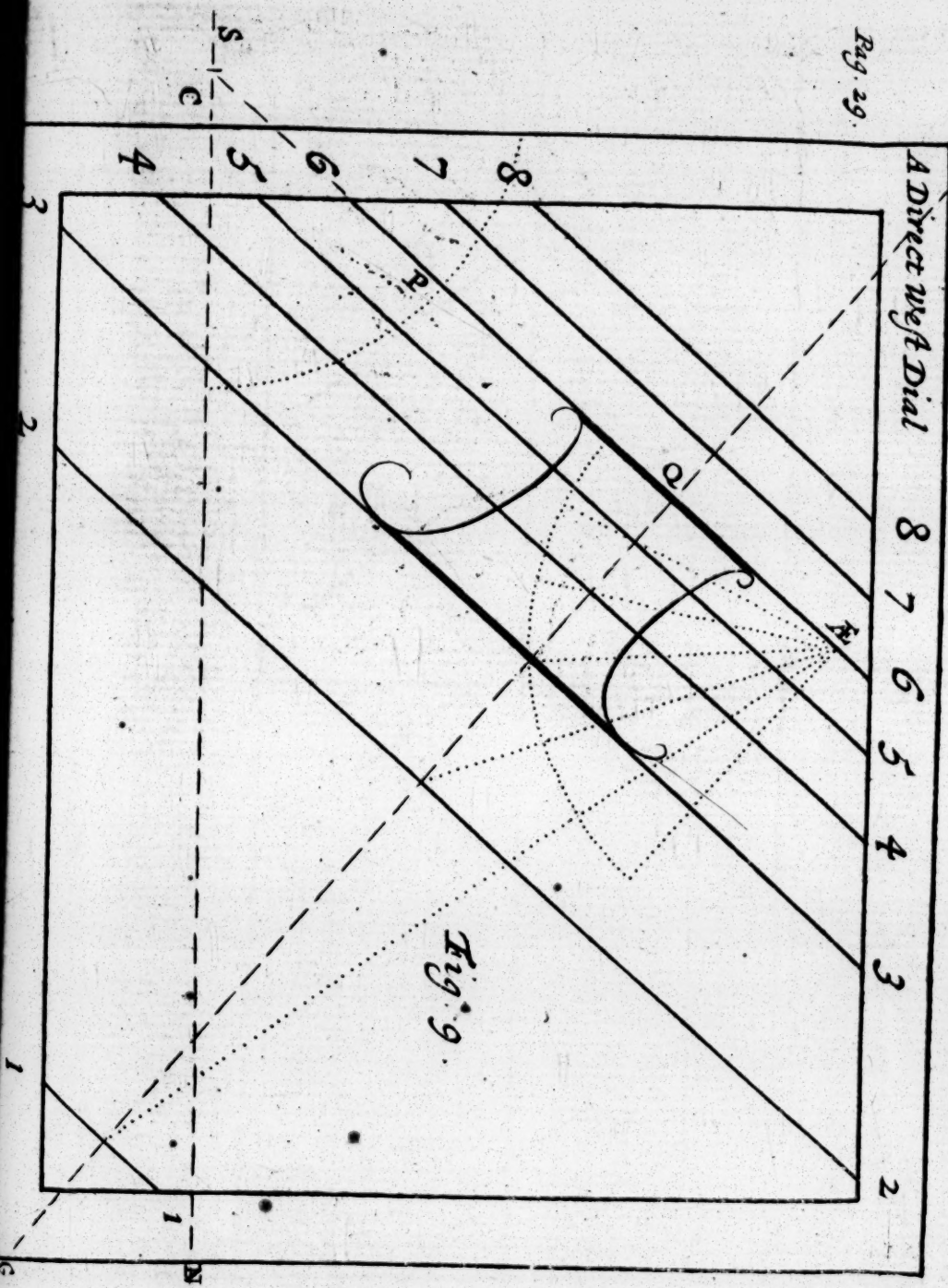
2. *To find the Substyle.* Taking any Point C towards S, the south End of the Line NS for a Center, describe an Arch toward N; and upon that Arch set off the Height P of the Pole, and draw the Line CP for the Substyle.

(*) These also are frequently stiled only *Direct East* or *West* Dials.

Having



Fig. 29.



Place this facing pag. 26.

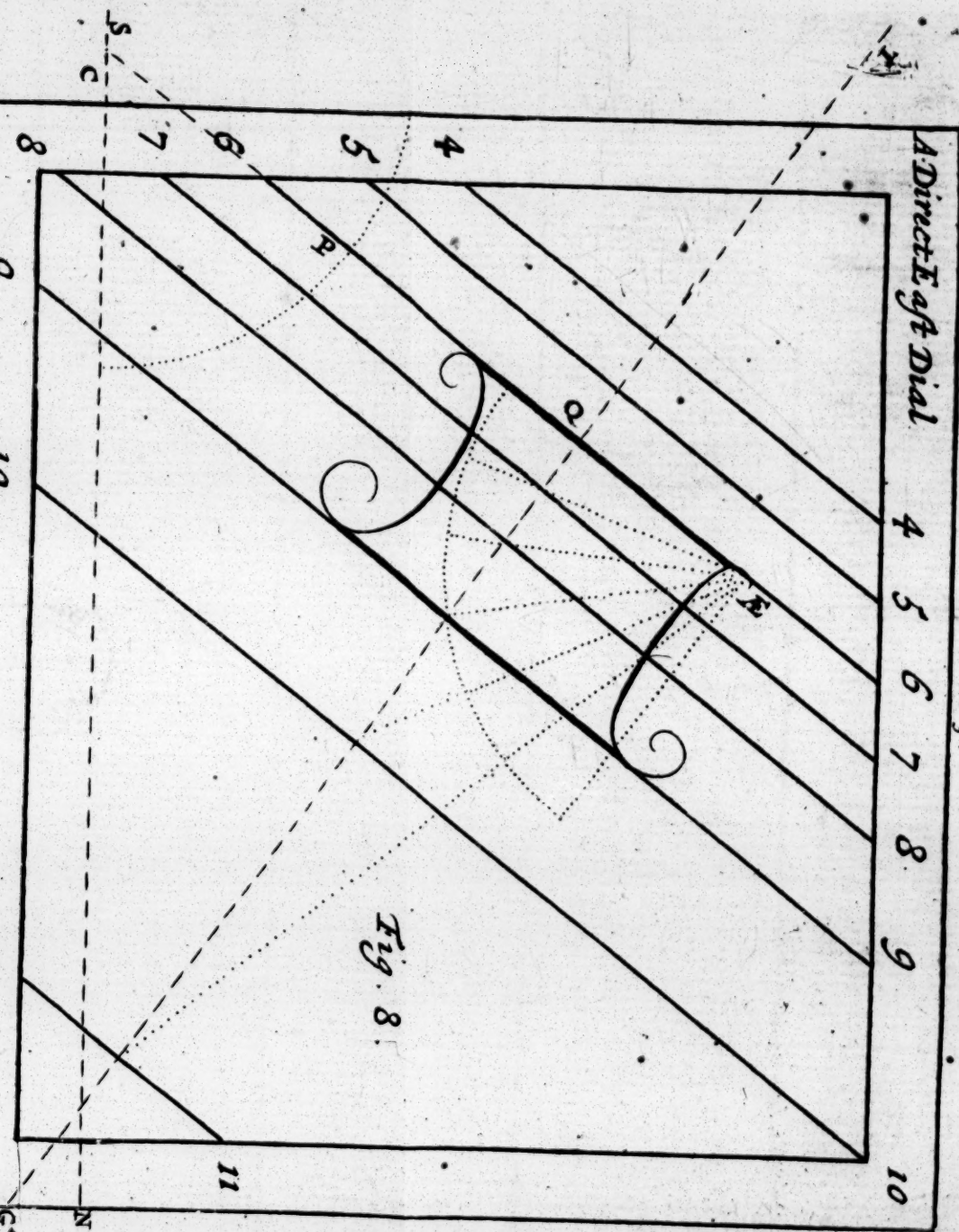
Dial Plate 3.

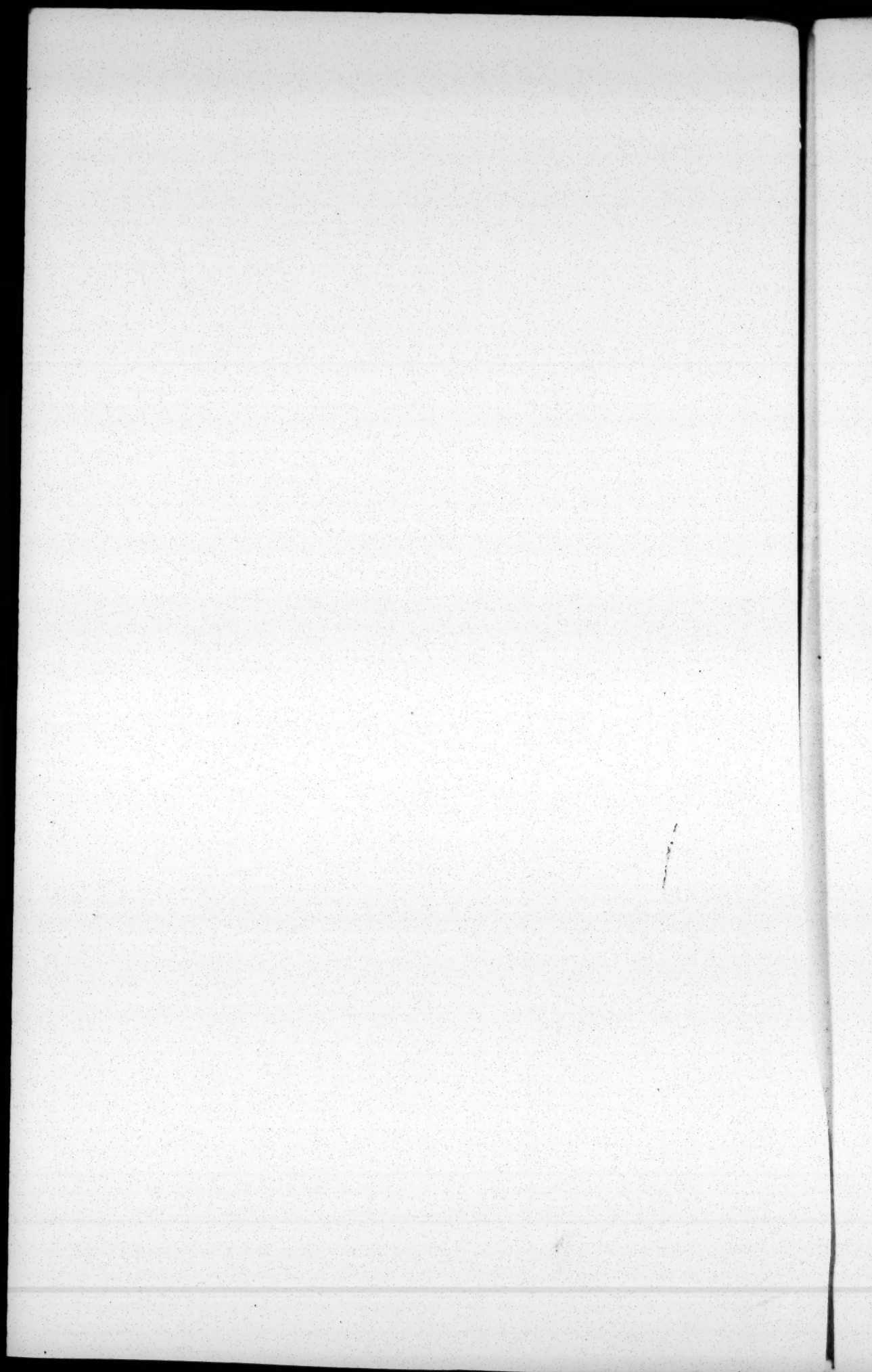
A Direct East Dial

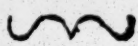
4 5 6 7 8 9

10

Fig. 8.





Having found the Substyle, draw CHAP. thereon the Contingent Line TG; and IV. then proceed to draw an (*) *Equinoctial*  Dial, taking any point Æ in the Sub- 3. style for the Center of the said *Equi-* To draw the Hour- *noctial* Dial. That Diameter of the Se- lines. micircle (representing half the *Equinoc-* *tial* Circle) which runs Parallel to the Contingent, is here the *Meridian* of the *Equator*; from which you are to begin to divide the Semicircle into Hours, or into 6 equal Parts, each containing 15 Degrees. Through each of these Divisions of the *Equinoctial* Semicircle draw Lines from Æ to the Contingent; and again through each Point of the Contingent, whereon the said Lines fall, draw other Lines (†) parallel to the Substyle. These last will be the Hour-lines; that which falls in with the Substyle CP being always the 6 a Clock Line; those above it the Hour-lines of

(*) There is no Mention made of drawing a Direct East or West Dial by *Scales* and *Tables*, because it is in Effect done both Ways, by the Help of the *Equinoctial* Dial.

(†) Because the Axis of the World runs *parallel* to the Plane of the *Meridian* (as may be shown by the Dialling Sphere,) and so must be conceived to cast its Shade parallel also to its self.

CHAP. the Hours before 6, and those below it
IV. the Hour-lines of the Hours after 6.

Where it is to be noted, that as 4 and 5 are the only Hours before 6, which need be inscribed on this Dial ; because the Sun never rises to us till after 3 ; so the Hours to be inscribed on this Dial after 6, are no more than 7, 8, 9, 10, and 11 ; forasmuch as this Dial-plane representing the Plane of the *Meridian*, the Sun shines not upon its Surface, but upon its south Side or Edge, at 12 a Clock.

4. To place the Style. The Hour-lines being drawn, the Style is to be placed (*) parallel to the Substyle CP, and so far distant from it, as the Center $\text{\AA}$ of the *Equinoctial* was taken distant from the Contingent. And so the Dial is finished ; as *Fig. 8*.

5. To draw a Direct West Dial. A *Direct West* Dial differing from a Direct East Dial primarily in this alone, that the former represents the west Side

(*) Because the Style represents the Axis of the World, which runs parallel to the Plane of the *Meridian*, Hence Direct East and West Dials have no Centers, through which the Axis passes, and from which consequently are to be drawn all the Hour-lines, as in *Horizontal* and Direct South and North Dials ; which are therefore called *Central* Dials.

of the Plane of the *Meridian*, and the latter the east Side ; hence the drawing of a Direct West Dial, is the same with that of a direct East Dial, excepting only the different Denominations of the Hours to be inscribed on this Dial, *viz.* 1 to 8 in the Afternoon ; which must be placed respectively from 6, (the Hour-line whereof always falls in with the Substyle,) as the Morning Hours are in a Direct East Dial. See *Fig. 9.*

How these Dials, when drawn, are to be placed, so as to have a due Situation in respect of the Heavens, is shewn in the following Chapter.

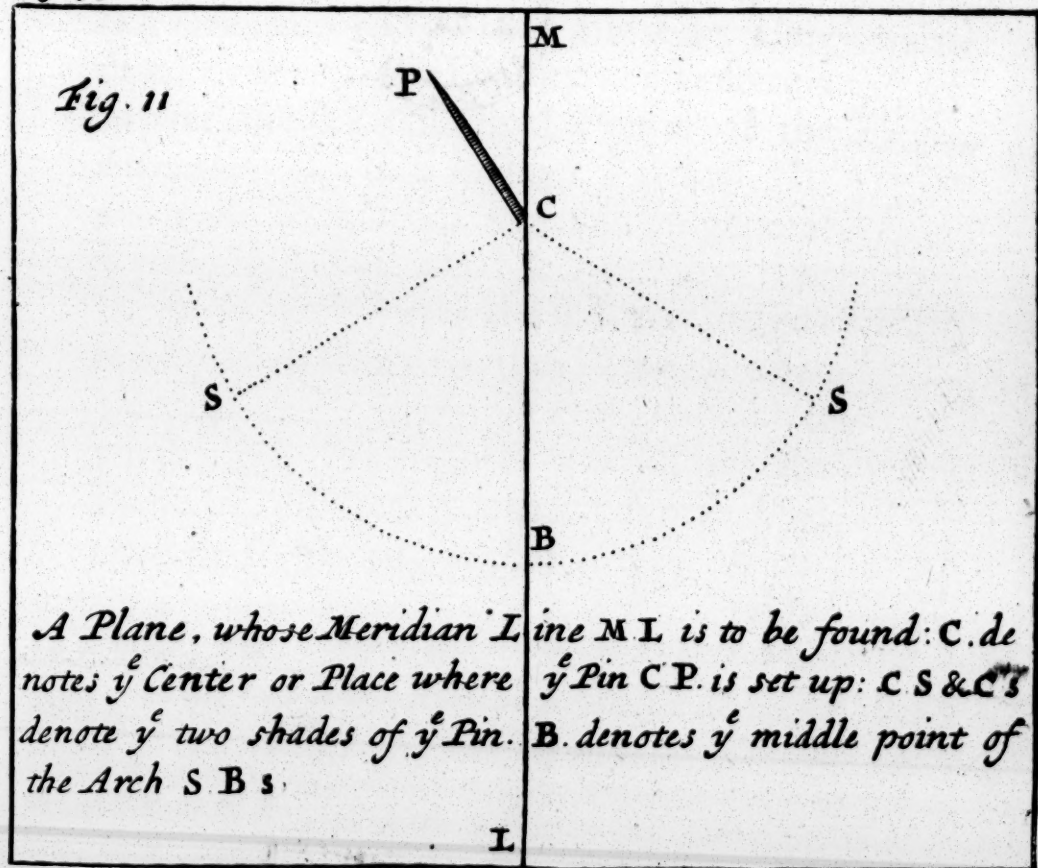
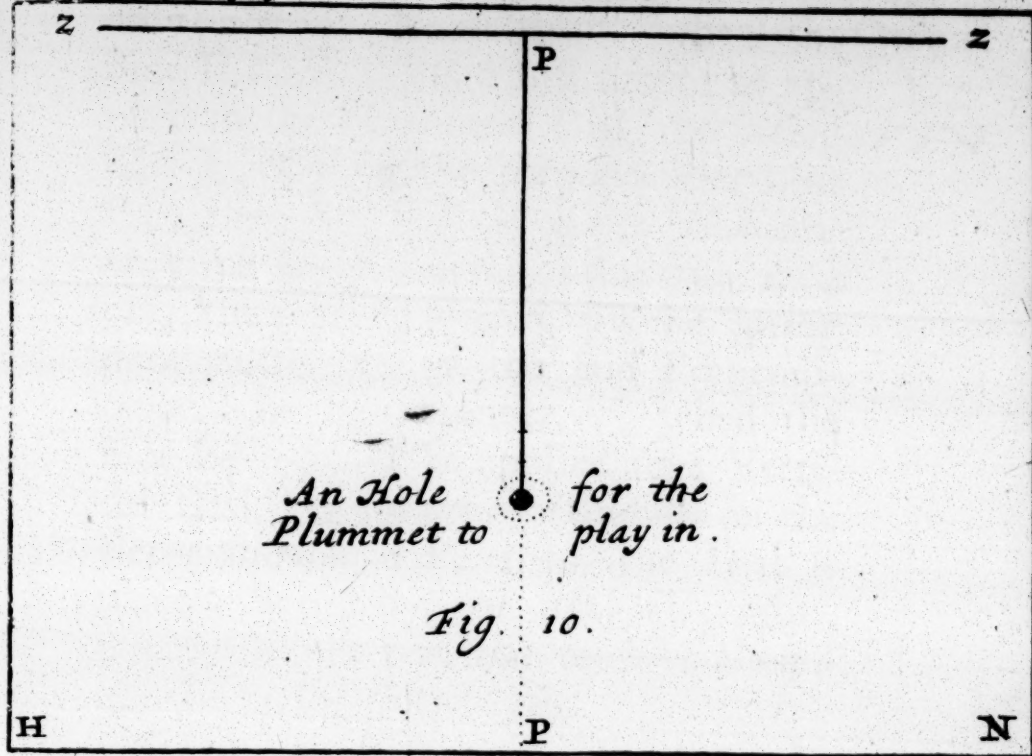


C H A P. V.

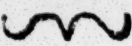
Of duly PLACING a Direct (East, or West, North, or South,) Dial; and of the Manner of finding, whether a Wall has a DIRECT or DECLINING POSITION or SITUATION.

CHAP. V. **E**VERY Dial-plane representing the Plane of some Circle in the Heavens, therefore, when any Dial is drawn, that it may go true, it is requisite that its Plane be so placed, as to answer exactly to the Plane of the Celestial Circle, which it represents. Wherefore, if it be an *Horizontal* Dial, its Plane must be placed *Horizontally*, or parallel to the *Horizon*, i. e. exactly level. If it be any *Vertical* Dial, (as a direct North or South, East or West Dial,) it must be placed *Vertically*, i. e. perpendicular to the *Horizon*, or exactly Upright. Now the Instrument represented, *Fig. 10.* will shew, when any of the fore-mentioned Dials are thus duly

A Dial is then duly placed, when its Plane answers to the Plane of the Celestial Circle, which it represents. In order whereto the Dial-Plane must be placed parallel to its respective Celestial Plane.

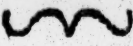




duly placed. Namely, if, when the CHAP. Side HN of the said Instrument be applied to the *Horizontal* Dial, the String V.  falls exactly on the perpendicular Line PP, then the Dial is placed *Horizontally*, or truly Level; otherwise it is not, but must be altered, till the Spring does exactly fall on the said Perpendicular. In like manner, if, when the Side ZN or ZH be applied to a Vertical Dial, the String exactly falls on the Perpendicular PP, then the Dial is placed Vertically, or truly Upright; otherwise it is not, but must be altered till the String does so fall.

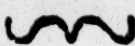
Again, an *Horizontal* Dial must be 2. placed not only *Horizontally* in general, but also so, as that the four Cardinal Points of the Dial may respectively answer the like Cardinal Points of the *Horizon*. In like manner Vertical Dials must be placed, not only in general Vertically, but also so, as that the Plane of each Vertical Dial may be parallel or answer to the Plane of that Vertical Circle in the Heavens, which it particularly has respect to. Thus the Plane of a Direct South or North Dial must be so placed, as that it may be parallel

And 2dly. The Cardinal Points of the Dial-plane must answer to the Cardinal Points of its respective Celestial Plane.

CHAP. V. rallel to the Plane of the Prime Vertical, which it represents, and that it may
 respectively answer to the south or north Side of the said Plane of the Prime Vertical. In like manner, the Plane of a Direct East or West Dial must be so placed, as that it may be parallel to, or fall in with the Plane of the *Meridian*, which it represents; and that it may respectively answer to the east or west Side of the said *Meridian* Plane.

3. Now in Order thus to place aright any of the fore-mentioned Dials, it is requisite to find where the *Meridian* crosses the Place, on which you would put the Dial. And this may be done several Ways. The most easy is by the Help of (what is called) the Mariners Needle, supposing it has none, or but little Variation in the Place where you are. For then the *Meridian* runs over, or parallel to the Length of the said Needle. Another Way is by holding up a String, when the Sun is in its *Meridian* Altitude, (which is to be found by the Quadrant,) for then the Shade of the String will represent the *Meridian* Line
of

To find the
Meridian
Line of
any Plane
or Place.

of the Place where you are. Another CHAP. V.
Way, somewhat longer, but much surer,
is this: Any Time in the Morning, 
when the Sun shines, erect any Pin or
straight piece of Iron or Wood, and
mark where the End of its Shade falls.
See Fig. 11.

Then on the Point, where the Pin
was erected, as on a Center, draw a
Circle passing through the other Point,
where the End of the Pin's Shade fell.
After which erecting the Pin again
where it was, wait till the End of the
Pin's Shade touches the Circle in some
other Point. The Arch between the
two Points of the Circle, on which
the End of the Pin's Shade fell at the
two several Times, being bisected or
divided exactly in Half, a right Line
drawn from the Center of the said Cir-
cle (*i. e.* from the Point where the Pin
was erected) through the Point of Bi-
section will be the *Meridian* Line of the
Place where you are.

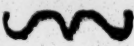
The *Meridian* Line of the Place 4.
where you are, being thus found out To place a-
by one or more of the fore-mentioned right an
Ways, an *Horizontal* Dial is truly Horizontal
placed, Dial.

CHAP. placed, (so as that its Cardinal Points
 V. shall answer the like Points of the
 *Horizon*,) by placing the *Meridian*
 Line (or which is the same, the 12
 a Clock Line) of the said *Horizontal*
 Dial exactly upon, or parallel to the
Meridian Line of the Place where you
 are. For the *Meridian* Line of the
 Dial being thus placed upon, or paral-
 lel to the *Meridian* Line of the Place,
 the North and South Points of the *Ho-*
rizontal Dial, being no other than
 the North and South Ends of the *Me-*
ridian Line of the Dial, will answer
 to the North and South Points of the
Horizon of the Place, these directly
 answering to the North and South
 Ends of the *Meridian* Line of the Place.
 And the North and South Points of
 the Dial being thus placed so, as to
 answer to the said Points of the *Hori-*
zon; the East and West Points of the
 Dial (if rightly drawn) will likewise
 answer to the East and West Points of
 the *Horizon*.

5.
 To place
 aright a
 Direct
 East or
 West Dial.

The Method of placing aright a
 Direct North or South, East or West
 (as well as of an *Horizontal*) Dial
 does likewise depend on the *Meridi-*
 an

an Line of the Place. For having CHAP.
found this by one or more of the V.

Ways above-mentioned, in order to 
place aright a direct East or West
Dial, all that is to be done, is only
this, *viz.* directly upon or parallel to the
said *Meridian* Line of your Place, you
must erect the Dial with the Face of it
Eastward, if it be a direct East Dial;
or Westward, if it be a direct West
Dial.

In order to place aright a direct 6.
North or South Dial a little more is *To place*
to be done. Namely, having found *aright a*
the *Meridian* Line of your Place, you Direct
must draw another Line crossing the South or
former perpendicularly, which will North
be the Prime Vertical Line of the Dial.
Place. Upon which therefore direct-
ly, or parallel to it, must be placed
the Dial with the Face of it south-
ward, if it be a direct South Dial; or
northward, if it be a direct North
Dial.

Hitherto we have considered Dials, 7.
as drawn on *Moveable* Planes, or *Of Un-*
Planes not already Fixed. And on *movable or*
such as are usually drawn *Horizontal* *Fixed Di-*
Dials. But Vertical Dials, (whether *al-planes.*
Direct

CHAP. Direct or Declining) are more usu-
 V. ally drawn on *Unmoveable* or Fixed
 ~~~~~ Planes, namely, on the Sides of some  
 Wall. Wherefore in order to draw  
 a Vertical Dial on a Wall, it is re-  
 quisite first to know, whether the  
 Wall be a direct East or West, North  
 or South Wall, or a Declining Wall;  
 and if the latter, how great its Decli-  
 nation is.

8. Now there are several Ways de-  
 livered in Treatises of Dialling for to  
 do this; but such as require, ei-  
 ther a peculiar Instrument called from  
 its Use a *Declinatory*, or else the  
 Sun's *Azimuth* to be taken, or both.  
 Wherefore I think the following Me-  
 thod is to be preferred before any  
 other, on Account of its Easiness,  
 and withal Exactness. To the Wall,  
 whose Situation you would know,  
 adjoin a Board so, as that one of its  
 Sides may touch the Wall, and the  
 Surface of the Board may lie *Hori-  
 zontally*, and fast. Upon the Board  
 thus prepared find the *Meridian* by  
 the last of the three Ways above-  
 mentioned, and draw a Line on the  
 Board representing the same, which  
 therefore

To know  
 when a  
 Wall is  
 Direct  
 East or  
 West, North  
 or South.





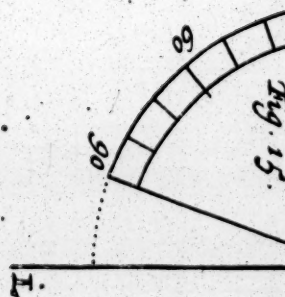
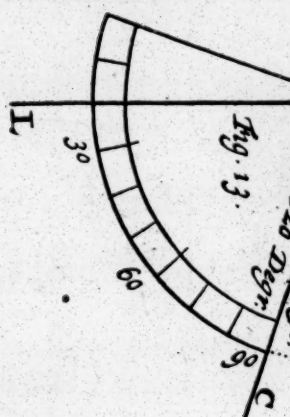
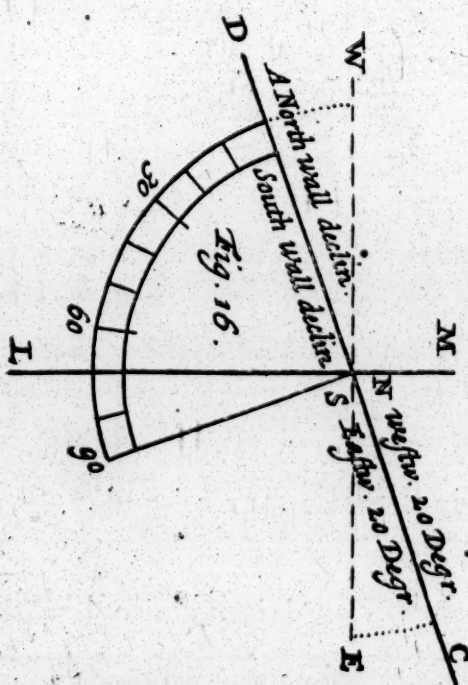
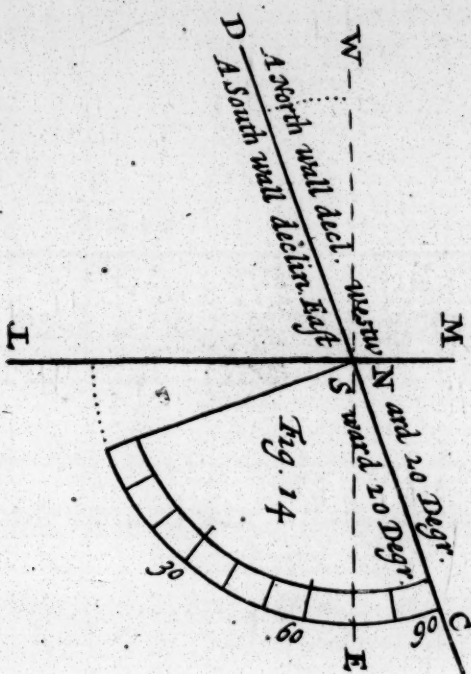
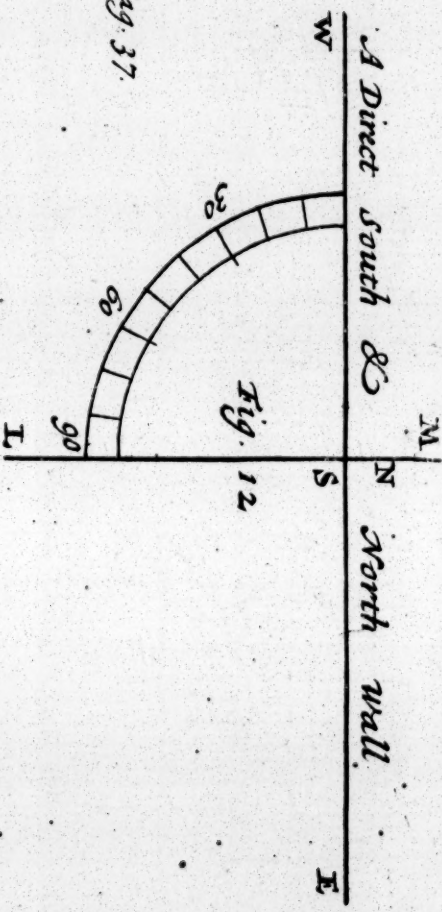


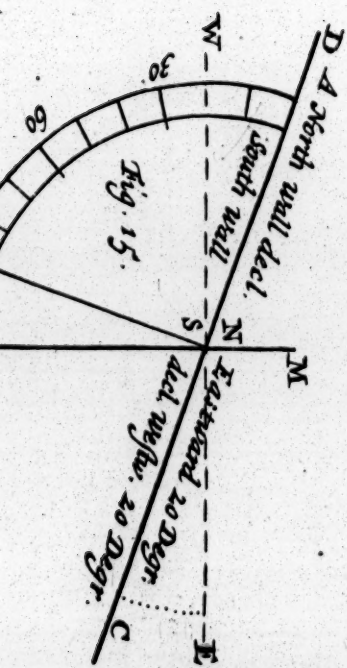
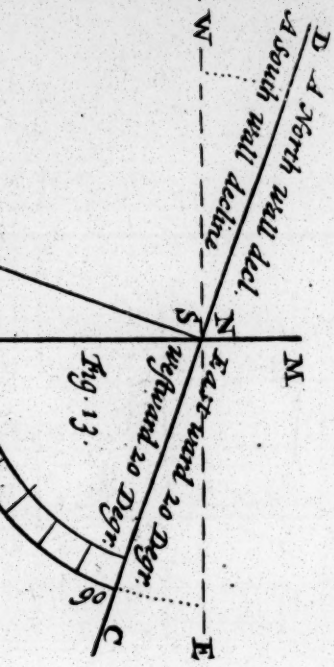
Fig. 20 Degr. C



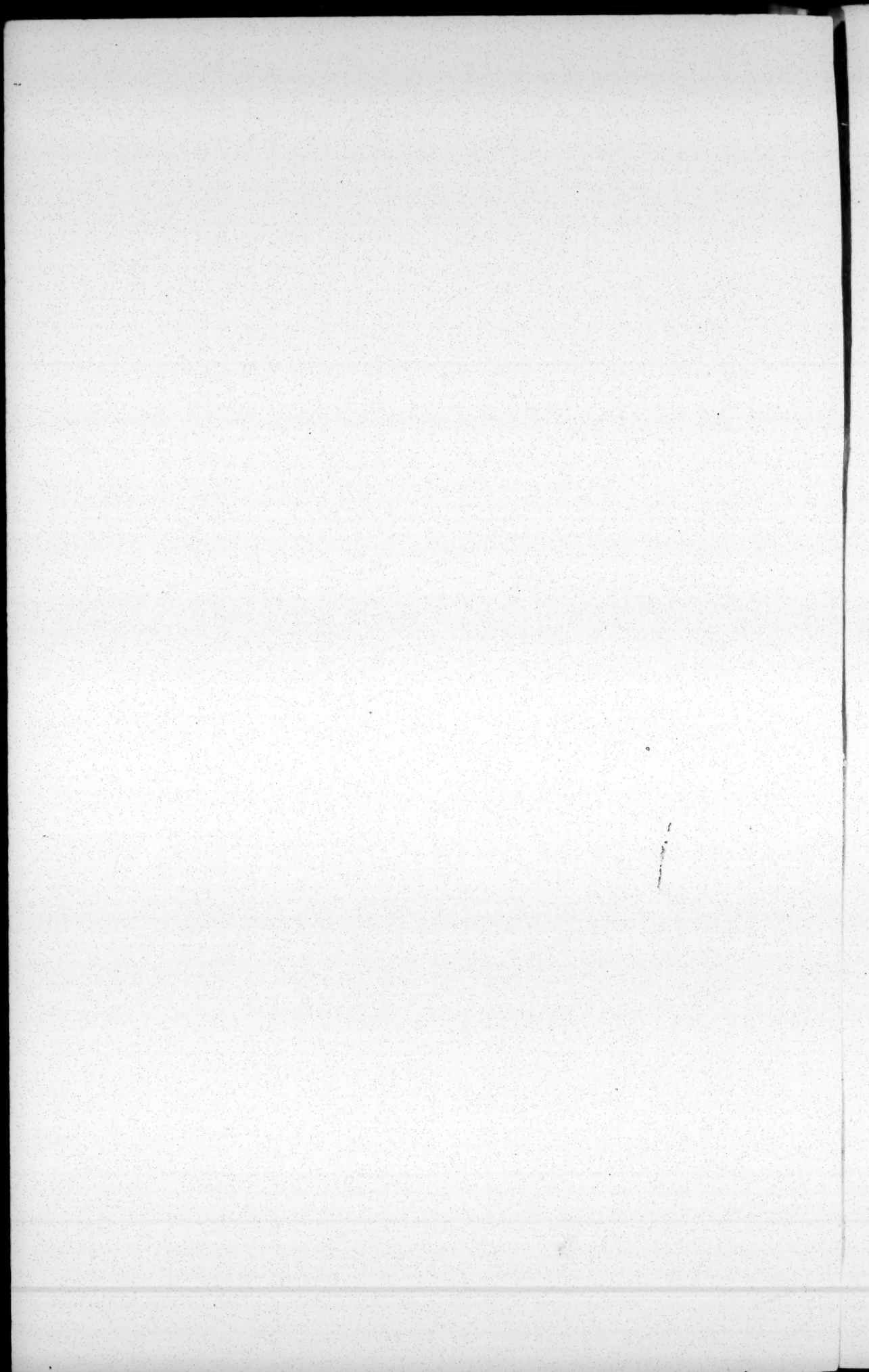
Dial Plate 7.

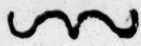


Place this facing Fig. 37.



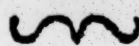




therefore we call the *Meridian* Line. CHAP.  
 If the *Meridian* Line falls in with, V.  
 or runs parallel to your Wall, then   
 it is a direct East or West Wall. If  
 not so, then lay a Quadrant flat upon  
 the said Board, with one of its Sides  
 or Edges applied to the Wall, and  
 its Center at the same Time on the  
*Meridian* Line. If the other Side  
 falls upon the *Meridian* Line drawn  
 on the Board, then the Wall is a  
 direct North and South Wall, *i. e.*  
 that Side of the Wall which is to-  
 ward the Sun and you, directly Faces  
 the South; and the other Side of it  
 consequently Faces directly the North.  
 See *Fig. 12.*

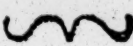
But, if when one Side of the Qua- 9.  
 drant is applied to the Wall as afore,<sup>To know</sup>  
 the other Side does not fall upon the<sup>when a</sup>  
*Meridian* Line on the Board, then it<sup>Wall de-</sup>  
 is a declining Wall. And if when  
 the right Side or Edge of the Qua-  
 drant is applied to the Wall, the *Me-*  
*ridian* Line of the Board is beyond,  
 or without the other Side of the Qua-  
 drant, then the Wall in respect of  
 its south Side declines Eastward, in  
 respect of its north Side Westward,  
 (as

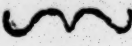
CHAP. (as *Fig. 14.*) but if the *Meridian*

V.  Line of the Board be within the left Side of the Quadrant, then the Wall in respect of its south Side declines Westward, in respect of its north Side Eastward, as *Fig. 13.* On the contrary, if the left Side or Edge of the Quadrant be applied to the Wall, and the *Meridian* Line on the Board be without the right Side of the Quadrant, then the Declination of the Wall in respect of its south Side is Westward, in respect of its north Side Eastward (as *Fig. 15.*): but if the said *Meridian* Line be within the right Side of the Quadrant, then the Declination of the Wall in respect of its south Side is Eastward, and in respect of its north Side Westward, as *Fig. 16.*

10. Having thus found, whether the Wall declines Eastward or Westward, *To find the Degrees of Declination.* it remains to find, how great its Declination is. Now, as when, one Side of the Quadrant being duly applied (as afore) to the Wall, the other Side falls exactly upon the *Meridian* Line of the Board, the Wall has no Declination; so when the other



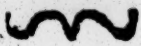
other Side of the Quadrant does not CHAP.  
fall exactly upon the said *Meridian* V.  
Line, then the Number of Degrees con-   
tained in the Angle made by the said  
other Side of the Quadrant, and the  
said *Meridian* Line is the Measure of the  
Declination. Wherefore as often as the  
said *Meridian* Line falls within the  
Quadrant, the Number of Degrees in-  
tercepted between the said *Meridian*  
Line, and that Side or Edge of the  
Quadrant which is not applied to the  
Wall, is the Measure of the Wall's De-  
clination. But if the *Meridian* Line  
falls without the Quadrant, then having  
drawn on the Board a Circle, with a  
Ray equal to that of the Quadrant, and  
upon that Point of the *Meridian* Line  
whereon you place the Center of the  
Quadrant, as the Center of the said  
Circle, thereupon take with the Com-  
passes the Distance between the *Meri-  
dian*, and that Edge of the Quadrant,  
which is not applied to the Wall: The  
said Distance applied to the Division  
of the Quadrant into 90 Degrees, will  
thereby shew the Measure of the Wall's  
Declination.

CHAP. All that has been aforesaid, is illustrated by (\*) *Fig. 12, 13, 14, 15, and*  
 *16.* In each of which the Line ML

11. denotes the *Meridian* Line; the Line  
*Illustra-* EW denotes the Plane of the Prime  
*tion by Ex-* Vertical, or ( which comes to the same)  
*amples.* the Plane of a direct South Wall or  
 Dial; and consequently E denotes the  
 true East Point, W the true West  
 Point, ESW the South Side of the  
 Plane of the Prime Vertical, or a direct  
 South Wall; ENW the north Side  
 of the Plane of the Prime Vertical,  
 or a direct North Wall: the Line  
 DC denotes a declining Wall. Where-  
 fore it is evident, that in *Fig. 12.*  
 one Edge of the Quadrant being duly  
 applied to EW the Wall, on the south  
 Side of it ESW, the other will fall  
 upon the *Meridian* Line, ML drawn  
 on the Board; and thereby shew, that  
 the said Wall EW has no Declina-  
 tion. But in *Fig. 13.* the right Edge

---

(\*) From all these Figures it is evident, that the Declination of a Wall or Dial, is the Arch WD or EC of the *Horizon* intercepted between the Plane of the Prime Vertical, and of the Wall or Dial.

of the Quadrant being applied to DC CHAP.  
 the declining Wall, and the *Meridian* V.  
 Line ML falling within the other   
 Side of the Quadrant, thereby is shewn,  
 that the Wall declines westward, and  
 also that the Measure of the Declina-  
 tion is 20 Degrees, this being the  
 Number of the Degrees intercepted  
 between the left Side of the Quadrant,  
 and the *Meridian* Line ML. In Fig.  
 14. the right Edge of the Quadrant  
 being applied to DC the Wall, and  
 the *Meridian* Line ML falling with-  
 out the left Edge of the Quadrant, I  
 take with my Compasses, on a Circle  
 described as above directed, the Di-  
 stance between ML the *Meridian*  
 Line, and the left Edge of my Qua-  
 drant, and applying the same to the  
 Division of the Quadrant into 90 De-  
 grees, I find the Measure of the said  
 Distance to be 20 Degrees; which con-  
 sequently is the Measure of the Declina-  
 tion of the Wall DC eastward. And  
 after the same Manner, the fore-menti-  
 oned Method of finding the Declina-  
 tion of a Wall may be illustrated in  
 all other Respects.



CHAP. Having thus shewn how to find  
V. the Declination of a Wall, it re-  
mains only to shew how to draw  
a Dial upon a declining Plane or  
Wall.

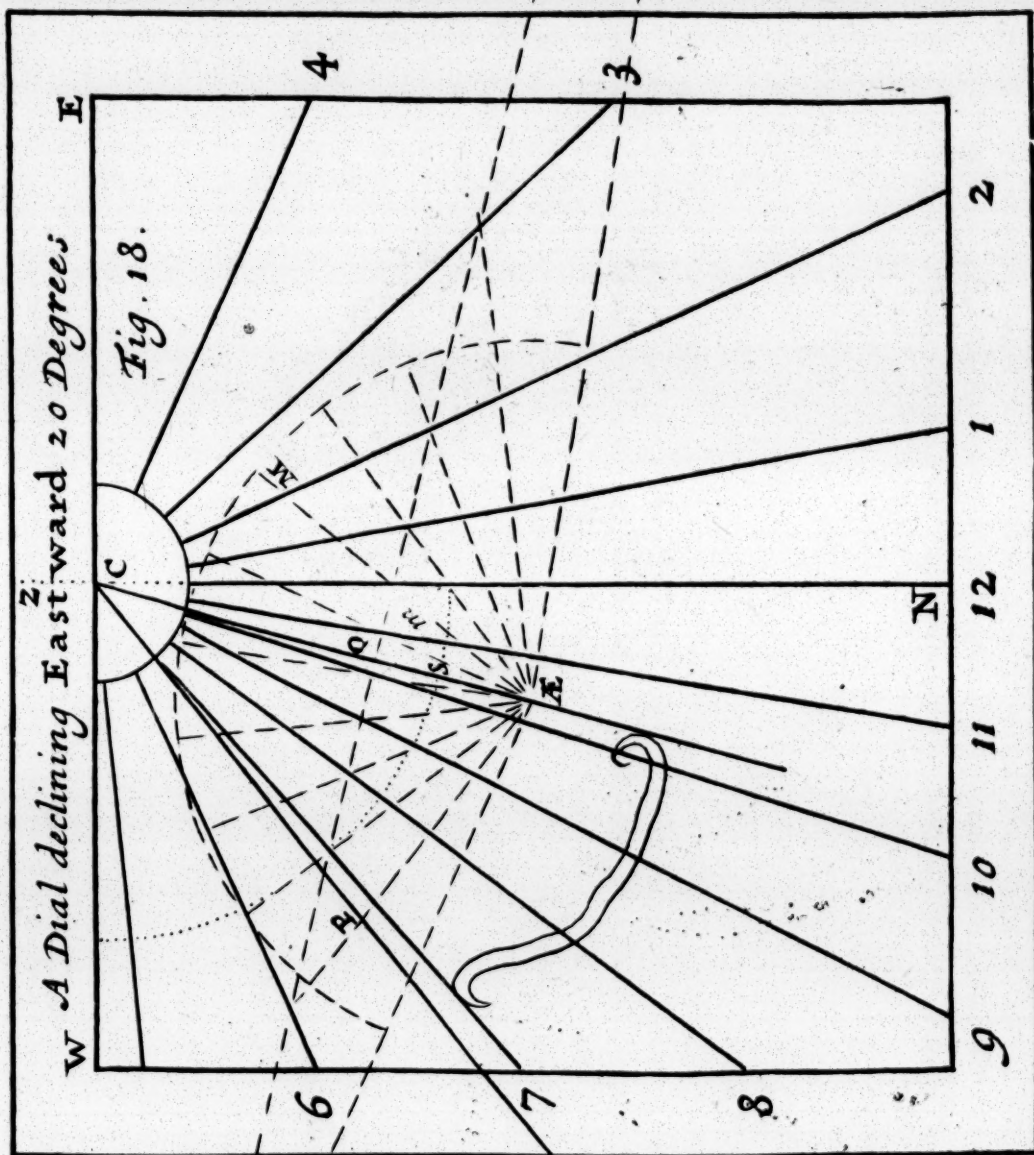


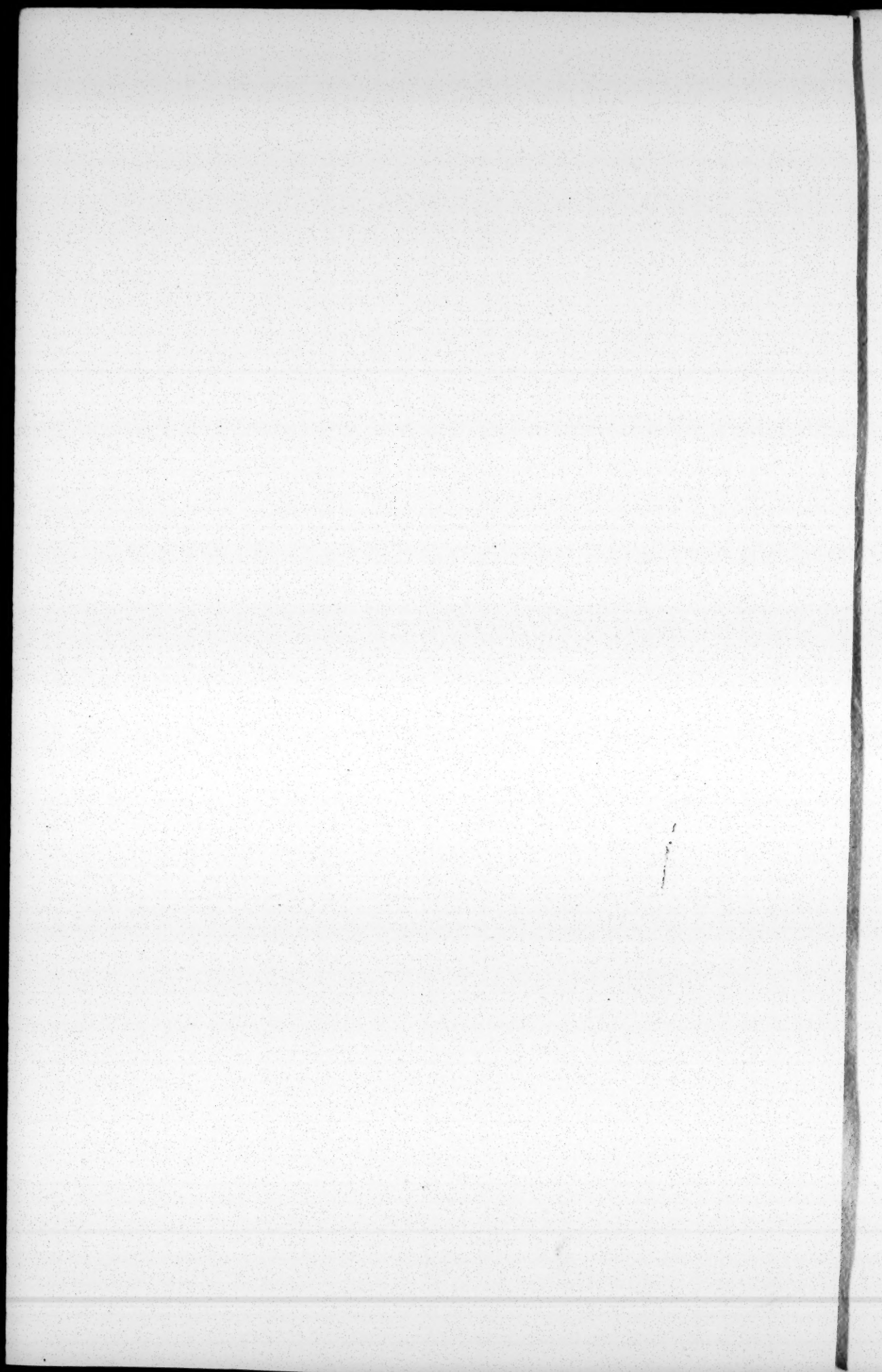
CHAP.











## C H A P. VI.

*Of drawing a DECLINING Dial.*

THE principal Difficulty in drawing a Declining Dial, is in finding the Distance of the Substyle from the *Meridian* or 12 a Clock Line, and the Height of the Style above the Substyle. Now to remove this Difficulty, there is adjoined to the End of this Chapter, a Table shewing the said Particulars, answerable to any Degree of Declination, and which will serve for most Parts of *England*.

Having then drawn (as in a Direct South or North Dial) two Lines crossing each other perpendicularly, one ZN representing the *Meridian*, the other EW representing the Prime Vertical; if you work by Dialling-Tables, turn to the said Table (*viz.* Tab. III.) and see what is the Substyle's Distance from the *Meridian* answerable to the Declination of

C H A P. VI.

I.

The chief Difficulty in drawing a Declining Dial.

2.

To find the Substyle and Style of a Declining Dial by Dialling Tables.



CHAP. the Wall, which, supposing the Declination 20 Degrees, will be 15 Degrees, 5 Minutes. Then draw an Arch from Z N to E W, on the West Side of Z N, if the Declination be eastward; and on the east Side, if the Declination be westward. On the said Arch set off from Z N the found Distance of the Substyle, viz. at S in Fig. 17. and 18. The Line C S, drawn from C (the Intersection of Z N and E W, and the Center of the Dial) to S, will be the Substyle. Then in the Table see what is the Style's Height answerable to the Declination, v. g. of 20 Degrees, and it is 35 Degrees, 34 Minutes. Set this off from S to P, and draw the Line C P, which will shew the Style.

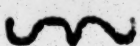
3. Having found the Substyle and the Style, draw (as afore in an *Horizontal*, and direct South or North Dial) the Contingent Line crossing the Substyle at right Angles in any Point Q: only the Substyle C S being here different from the *Meridian* Z N, mark the Point *m* of the *Meridian* where it

To draw  
the Hour-  
Lines.

it is crossed by the Contingent. CHAP. VI.  
 Then taking (as afore in the other Dials) the Point  $\text{Æ}$  in the Substyle for the Center of an *Equinoctial* Dial, draw a (\*) Semicircle; one Half of it being on one Side of the Substyle, and the other Half on the other Side. After which draw the Line  $\text{ÆM}$  cutting the *Equinoctial* Semicircle in  $\text{M}$ . The Line  $\text{ÆM}$  will be the *Meridian* of the *Equinoctial* Dial, from which you are to begin to divide on each Side the *Equinoctial* Semicircle into *Hours*, or six equal Parts. Lines drawn from  $\text{Æ}$  through the said Divisions to the Contingent will be the *Equinoctial*

---

(\*) It is to be observed, that in Declining Dials the entire Semicircle must be drawn; and it is not sufficient to draw only one Half of the Semicircle as in Direct South and North Dials, forasmuch as the *Meridian* or 12 a Clock Line of the *Equator*, not falling in with the *Meridian* or 12 a Clock Line of the Declining Dial, (as it does in Direct North and South Dials,) hence the Divisions on each Side the 12 a Clock Line of the *Equinoctial*, will not cut the Contingent at equal respective Distances, as in Direct North and South Dials.

CHAP. Hours. And consequently Lines drawn  
 VI. from C the Center of the declining  
 Dial to the same Points of the Con-  
 tingent, whereon the *Equinoctial* Hour-  
 lines fall, will be the Hour-lines for  
 the declining Dial, (as afore in an  
*Horizontal* and Direct North or South  
 Dial,) and so the Dial will be finished.  
 See *Fig. 17* and *18*.

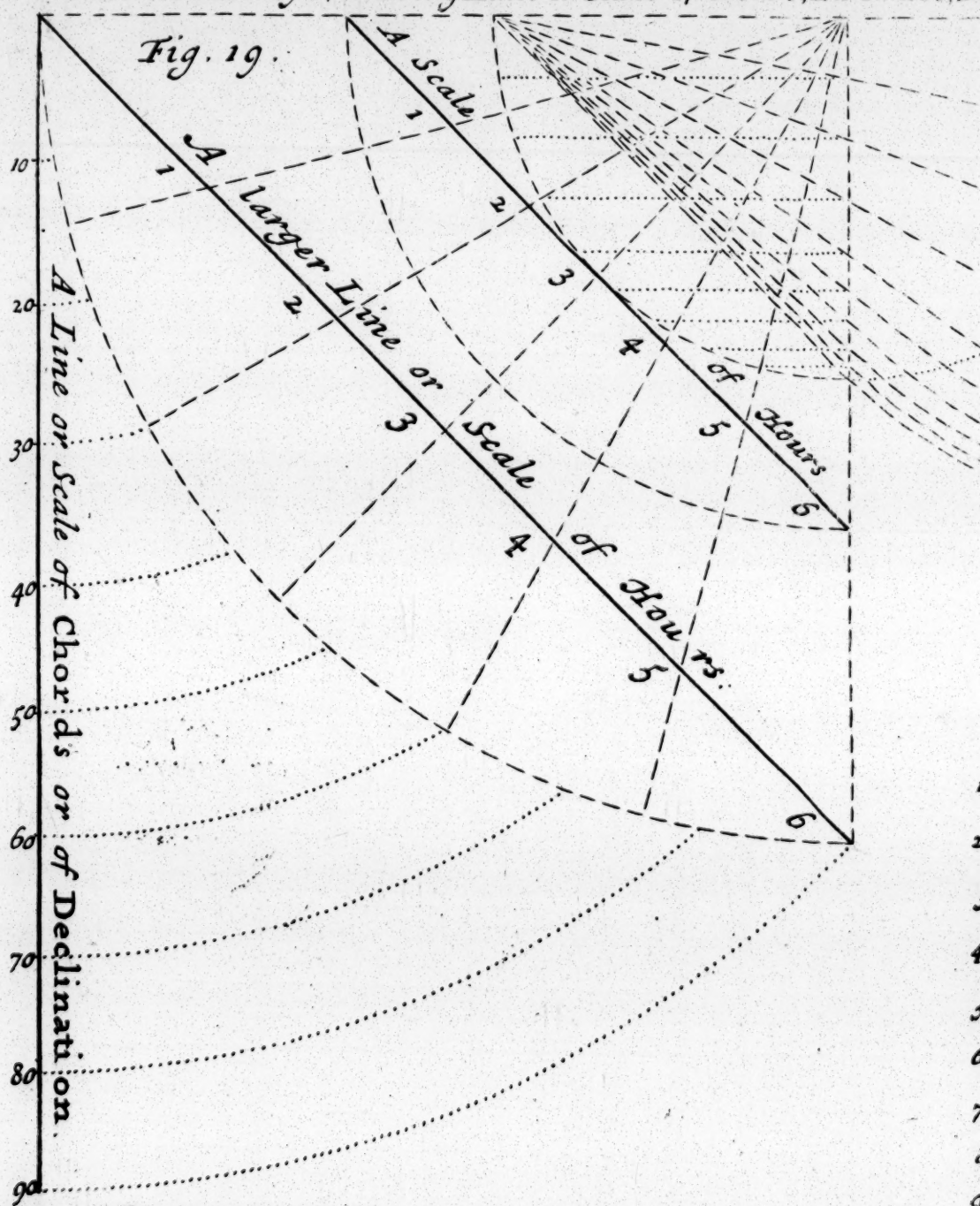
4.  
 The Con-  
 clusion.

And thus I have gone through  
 those Elements of Dialling, which  
 I judge most requisite to be known  
 by Young Gentlemen, at least at  
 their first Institution in the said Art  
 or Science. What follows, are such  
 Dialling *Tables* as are requisite to  
 this Treatise; which though cal-  
 culated indeed for the Latitude of  
*Oxford*, (*viz.* 51 Degrees, 45 Mi-  
 nutes,) yet will serve without any  
 sensible Difference for most Parts  
 of *England*. The Dialling *Scales*, or  
 rather the Way of drawing Dial-  
 ling Scales, *viz.* the Lines or Scales  
 of *Latitude* and of *Hours*, (both  
 mentioned and made use of in this  
 Treatise) as also of *Inclination of*  
*Meridians*,

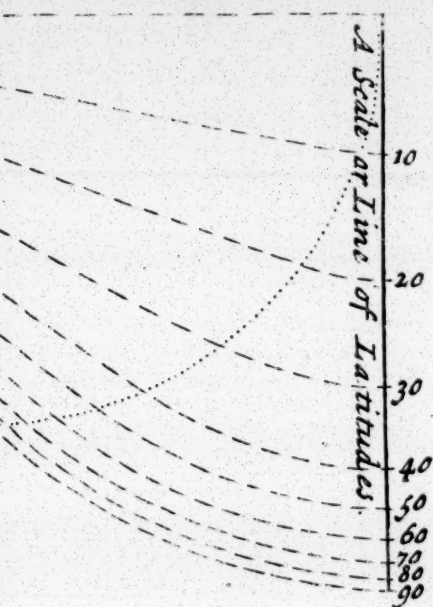




The Geometrical way of drawing Lines or Scales of Hours, Latitudes, D



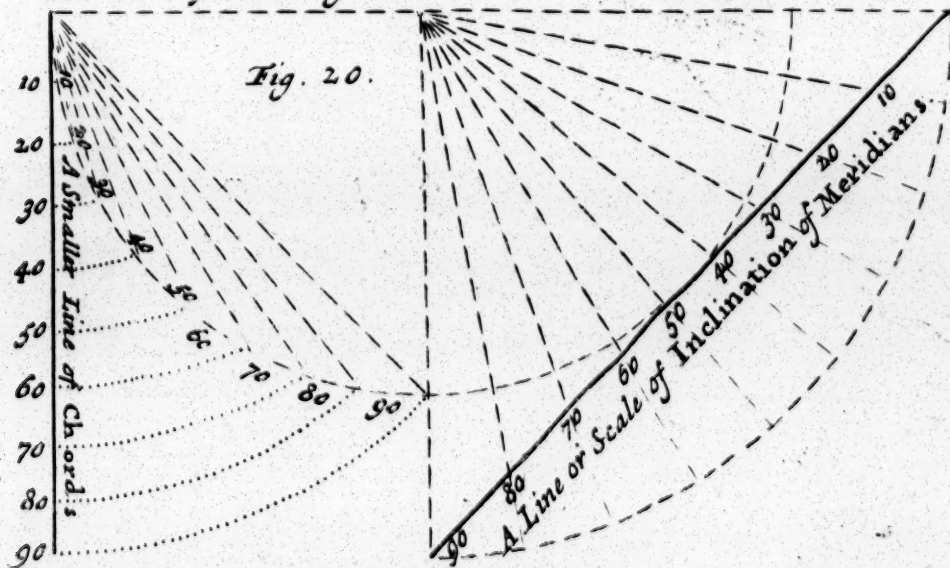
itudes, Declination or Chords.



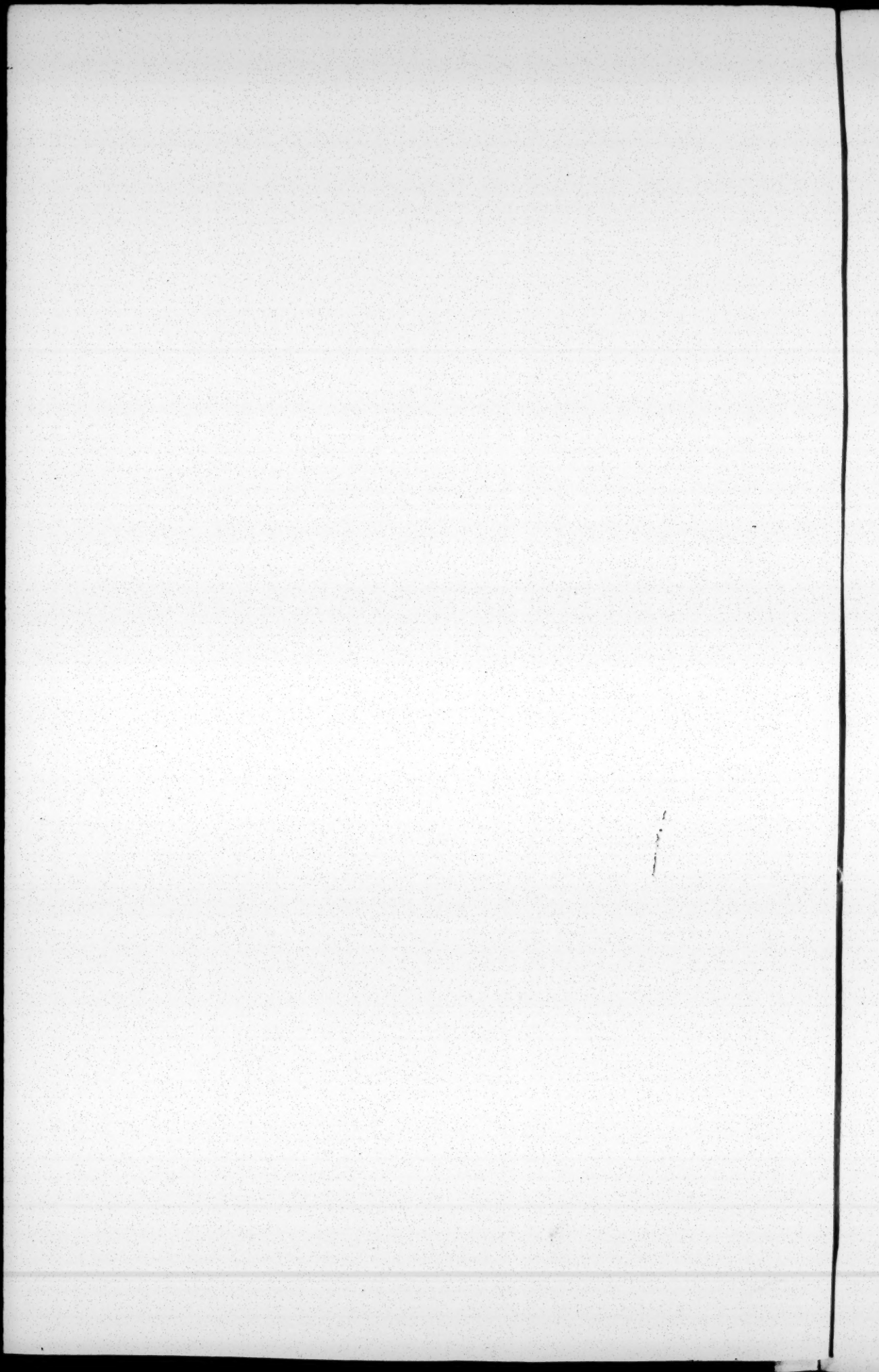
Dial. Plate 9.

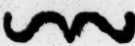
Place this facing pag. 47.

The Geom. way of drawing a Scale of Inclination of Meridians & Chords.







*Meridians, and of Declination* (not CHAP.  
mentioned in this Treatise, but put into VI.  
all Dialling Scales) is represented *Fig.*   
19. and 20.



TAB.

T A B. I.

Shewing what Angle every Hour-line, (as also Quarter, Half, and three Quarters of an Hour) makes with the *Meridian* or twelve a Clock Line, in an *Horizontal* Dial.

| Hours. | Degrees. | Minutes. |
|--------|----------|----------|
| 12     | 00 .     | 00 .     |
| 1      | 02 .     | 57 .     |
| 2      | 02 .     | 54 .     |
| 3      | 08 .     | 52 .     |
| II .   | 11 .     | 53 .     |
| I      | 14 .     | 55 .     |
| 2      | 18 .     | 01 .     |
| 3      | 21 .     | 10 .     |
| IO .   | 24 .     | 23 .     |
| I      | 27 .     | 41 .     |
| 2      | 31 .     | 04 .     |
| 3      | 34 .     | 33 .     |
| 9 .    | 38 .     | 09 .     |
| I      | 41 .     | 51 .     |
| 2      | 45 .     | 40 .     |
| 3      | 49 .     | 36 .     |
| 8 .    | 53 .     | 40 .     |
| I      | 57 .     | 53 .     |
| 2      | 62 .     | 11 .     |
| 3      | 66 .     | 37 .     |
| 7 .    | 71 .     | 09 .     |
| I      | 75 .     | 38 .     |
| 2      | 80 .     | 29 .     |
| 3      | 85 .     | 14 .     |
| 6 .    | 90 .     | 00 .     |

T A B. II.

Shewing the like Angles in a *Direct* South or North Dial.

| Hours. | Degrees. | Minutes. |
|--------|----------|----------|
| 12     | 00 .     | 00 .     |
| 1      | 02 .     | 19 .     |
| 2      | 04 .     | 40 .     |
| 3      | 07 .     | 01 .     |
| II .   | 09 .     | 25 .     |
| I      | 11 .     | 52 .     |
| 2      | 14 .     | 23 .     |
| 3      | 16 .     | 58 .     |
| IO ,   | 19 .     | 40 .     |
| I      | 22 .     | 28 .     |
| 2      | 25 .     | 24 .     |
| 3      | 28 .     | 30 .     |
| 9 .    | 31 .     | 46 .     |
| I      | 35 .     | 13 .     |
| 2      | 38 .     | 54 .     |
| 3      | 42 .     | 49 .     |
| 8 ,    | 47 .     | 00 .     |
| I      | 51 .     | 27 .     |
| 2      | 56 .     | 13 .     |
| 3      | 61 .     | 15 .     |
| 7 .    | 66 .     | 36       |
| I      | 72 .     | 11       |
| 2      | 77 .     | 00       |
| 3      | 83 .     | 58       |
| 6 .    | 90 .     | 00.      |

T A B.



## T A B. III.

Shewing the *Distance of the Substyle* from the *Meridian*, and the *Height of the Style* above the Substyle, answerable to the several Degrees of *Declination*.

| Declination. | Substyle's Distance from the Meridian. |          | Style's Height above the Substyle. |          |
|--------------|----------------------------------------|----------|------------------------------------|----------|
| Degrees.     | Degrees.                               | Minutes. | Degrees.                           | Minutes. |
| 1            | 0 .                                    | 47       | 38 .                               | 14       |
| 2            | 1 .                                    | 34       | 38 .                               | 13       |
| 3            | 2 .                                    | 21       | 38 .                               | 11       |
| 4            | 3 .                                    | 8        | 38 .                               | 8        |
| 5            | 3 .                                    | 55       | 38 .                               | 5        |
| 6            | 4 .                                    | 42       | 38 .                               | 0        |
| 7            | 5 .                                    | 28       | 37 .                               | 55       |
| 8            | 6 .                                    | 14       | 37 .                               | 49       |
| 9            | 7 .                                    | 2        | 37 .                               | 42       |
| 10           | 7 .                                    | 48       | 37 .                               | 34       |

Declination.

## T A B. III.

| Declina-<br>tion. | Substyle's Dif-<br>tance from the<br><i>Meridian.</i> |          | Style's Height a-<br>bove the Sub-<br>style. |         |
|-------------------|-------------------------------------------------------|----------|----------------------------------------------|---------|
|                   | Degrees.                                              | Minutes. | Degrees.                                     | Minutes |
| 11                | 8 .                                                   | 33       | 37 .                                         | 26      |
| 12                | 9 .                                                   | 18       | 37 .                                         | 16      |
| 13                | 10 .                                                  | 2        | 37 .                                         | 6       |
| 14                | 10 .                                                  | 48       | 36 .                                         | 55      |
| 15                | 11 .                                                  | 32       | 36 .                                         | 43      |
| 16                | 12 .                                                  | 15       | 36 .                                         | 31      |
| 17                | 12 .                                                  | 59       | 36 .                                         | 18      |
| 18                | 13 .                                                  | 41       | 36 .                                         | 2       |
| 19                | 14 .                                                  | 24       | 35 .                                         | 50      |
| 20                | 15 .                                                  | 5        | 35 .                                         | 34      |
| 21                | 15 .                                                  | 47       | 35 .                                         | 19      |
| 22                | 16 .                                                  | 27       | 35 .                                         | 2       |
| 23                | 17 .                                                  | 7        | 34 .                                         | 44      |
| 24                | 17 .                                                  | 47       | 34 .                                         | 26      |
| 25                | 18 .                                                  | 15       | 34 .                                         | 8       |
| 26                | 19 .                                                  | 4        | 33 .                                         | 49      |
| 27                | 19 .                                                  | 41       | 33 .                                         | 29      |
| 28                | 20 .                                                  | 19       | 33 .                                         | 8       |
| 29                | 20 .                                                  | 55       | 32 .                                         | 47      |
| 30                | 21 .                                                  | 31       | 32 .                                         | 25      |
| 31                | 22 .                                                  | 6        | 32 .                                         | 3       |
| 32                | 22 .                                                  | 40       | 31 .                                         | 40      |
| 33                | 23 .                                                  | 14       | 31 .                                         | 17      |
| 34                | 23 .                                                  | 47       | 30 .                                         | 53      |
| 35                | 24 .                                                  | 19       | 30 .                                         | 28      |

Decl-

## T A B. III.

| Declination. | Substyle's Distance from the Meridian. |          | Dif-Style's Height above the Substyle. |          |
|--------------|----------------------------------------|----------|----------------------------------------|----------|
|              | Degrees.                               | Minutes. | Degrees.                               | Minutes. |
| 36           | 24 .                                   | 52       | 30 .                                   | 3        |
| 37           | 25 .                                   | 23       | 29 .                                   | 36       |
| 38           | 25 .                                   | 53       | 29 .                                   | 12       |
| 39           | 26 .                                   | 23       | 28 .                                   | 45       |
| 40           | 26 .                                   | 52       | 28 .                                   | 18       |
| 41           | 27 .                                   | 21       | 27 .                                   | 51       |
| 42           | 27 .                                   | 49       | 27 .                                   | 23       |
| 43           | 28 .                                   | 16       | 26 .                                   | 55       |
| 44           | 28 .                                   | 42       | 26 .                                   | 26       |
| 45           | 29 .                                   | 8        | 25 .                                   | 57       |
| 46           | 29 .                                   | 33       | 25 .                                   | 29       |
| 47           | 29 .                                   | 58       | 24 .                                   | 58       |
| 48           | 30 .                                   | 22       | 24 .                                   | 28       |
| 49           | 30 .                                   | 45       | 23 .                                   | 58       |
| 50           | 31 .                                   | 8        | 23 .                                   | 27       |
| 51           | 31 .                                   | 30       | 22 .                                   | 56       |
| 52           | 31 .                                   | 51       | 22 .                                   | 24       |
| 53           | 32 .                                   | 12       | 21 .                                   | 52       |
| 54           | 32 .                                   | 32       | 21 .                                   | 20       |
| 55           | 32 .                                   | 51       | 20 .                                   | 48       |
| 56           | 33 .                                   | 10       | 20 .                                   | 15       |
| 57           | 33 .                                   | 28       | 19 .                                   | 42       |
| 58           | 33 .                                   | 46       | 19 .                                   | 9        |
| 59           | 34 .                                   | 3        | 18 .                                   | 35       |
| 60           | 34 .                                   | 19       | 18 .                                   | 2        |

Declination.



| T A B. III.       |                                                       |          |                                              |          |
|-------------------|-------------------------------------------------------|----------|----------------------------------------------|----------|
| Declina-<br>tion. | Substyle's Dif-<br>tance from the<br><i>Meridian.</i> |          | Style's Height a-<br>bove the Sub-<br>style. |          |
| Degrees.          | Degrees.                                              | Minutes. | Degrees.                                     | Minutes. |
| 61                | 34 .                                                  | 35       | 17 .                                         | 28       |
| 62                | 34 .                                                  | 50       | 16 .                                         | 54       |
| 63                | 35 .                                                  | 5        | 16 .                                         | 19       |
| 64                | 35 .                                                  | 19       | 15 .                                         | 45       |
| 65                | 35 .                                                  | 32       | 15 .                                         | 10       |
| 66                | 35 .                                                  | 46       | 14 .                                         | 35       |
| 67                | 35 .                                                  | 58       | 14 .                                         | 0        |
| 68                | 36 .                                                  | 10       | 13 .                                         | 44       |
| 69                | 36 .                                                  | 21       | 12 .                                         | 49       |
| 70                | 36 .                                                  | 32       | 12 .                                         | 13       |
| 71                | 36 .                                                  | 42       | 11 .                                         | 38       |
| 72                | 36 .                                                  | 51       | 11 .                                         | 2        |
| 73                | 37 .                                                  | 1        | 10 .                                         | 26       |
| 74                | 37 .                                                  | 9        | 9 .                                          | 34       |
| 75                | 37 .                                                  | 17       | 9 .                                          | 13       |
| 76                | 37 .                                                  | 25       | 8 .                                          | 37       |
| 77                | 37 .                                                  | 22       | 8 .                                          | 9        |
| 78                | 37 .                                                  | 37       | 7 .                                          | 24       |
| 79                | 37 .                                                  | 44       | 6 .                                          | 47       |
| 80                | 37 .                                                  | 50       | 6 .                                          | 10       |
| 81                | 37 .                                                  | 54       | 5 .                                          | 41       |
| 82                | 37 .                                                  | 59       | 4 .                                          | 57       |
| 83                | 38 .                                                  | 2        | 4 .                                          | 19       |
| 84                | 38 .                                                  | 6        | 3 .                                          | 43       |
| 85                | 38 .                                                  | 9        | 3 .                                          | 5        |

Decli-

| T A B. III.  |                                        |          |                                    |          |
|--------------|----------------------------------------|----------|------------------------------------|----------|
| Declination. | Substyle's Distance from the Meridian. |          | Style's Height above the Substyle. |          |
| Degrees.     | Degrees.                               | Minutes. | Degrees.                           | Minutes. |
| 86           | 38 .                                   | 11       | 2 .                                | 29       |
| 87           | 38 .                                   | 13       | 1 .                                | 52       |
| 88           | 38 .                                   | 14       | 1 .                                | 12       |
| 89           | 38 .                                   | 14       | 0 .                                | 37       |
| 90           | 38 .                                   | 15       | 0 .                                | 0        |

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A CATALOGUE of the several Draughts of Dials, and other Cutts belonging to this Treatise.

Fig 1. *A*N Horizontal Dial drawn by the Help of the Equinoctial Dial.

2. An Horizontal Dial drawn by the Help of dialling Scales.

3. An Horizontal Dial drawn by the Help of Dialling Tables.

4. A Direct South Dial drawn by the Help of the Equinoctial Dial.

5. *A*

5. *A Direct South Dial drawn by the Help of Scales.*

6. *A Direct South Dial drawn by the Help of Tables.*

7. *A Direct North Dial.*

8. *A Direct East Dial.*

9. *A Direct West Dial.*

10. *The Draught of an Instrument, whereby to find, whether a Dial-plane be truly Horizontal, or Erect.*

11. *The Draught of the most exact Method for finding the Meridian of a Place or Dial-plane.*

12, 13, 14, 15, 16. *Several Draughts representing the Method to find whether a Wall be Direct or Declining; and if declining, how many Degrees it has of Declination.*

17. *A Dial declining Westward 20 Degrees.*

18. *A Dial declining Eastward 20 Degrees.*

19. *The Geometrical Way of drawing Lines, or Scales of Hours, of Latitudes, and also of Declination, or (which comes to the same) of Chords.*

20. *The Geometrical Way of drawing a Line or Scale of the Inclination of Meridians.*

F I N I S.





